Books by William Shelton

COUNTDOWN
The Story of Cape Canaveral

FLIGHTS OF THE ASTRONAUTS

RUSSIAN SPACE EXPLORATION
The First Decade

AMERICAN SPACE EXPLORATION
The First Decade

AMERICAN
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by
William Shelton

Illustrated with Photographs

STERLING PUBLISHERS (P) LTD

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DELHI-6

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Jullundur 695 Model Town

Delhi-6 3640 Mori Gate

First Indian Reprint Edition 1969

Price Rs 4 00

PRINTED IN INDIA

Published by Shri S K Ghai Managing Director Sterling Publishers (P) Ltd and printed at Today & Tomorrow s Printers & Publishers Faridabad Haryana

For Helene

Contents

Acknowledgments

DURING THE ten-year period which this book covers the titles, jobs and status of many persons who assisted the author have inevitably changed In gratefully acknowledging this assistance I would like to use the rank held at the time each individual was first contacted or consulted

Of those who were of particular help before the advent of manned flight I wish to thank B G MacNabb Major General Donald N Yates George Shaw, Major Kenneth Grine Lieutenant Colonel Sidney Spear, Jo Downey, William Duval, Captain Tom Burleson Henri Landwirth Major Ballard Small Colonel H H Eichel Major Brandy Griffith Jack Kirby Captain Mike Sellers Major Fred Grinham, Major Salvatore Pelle, Brigadier General William Rogers Dr Hans Gruene, Dick Bate, David Ladd Lee Griggs and Rudy Faulkner

I am particularly grateful to Ken Senstad of the Atlantic Missile Range staff who reviewed all portions of this book dealing with the early days at Cape Kennedy and who offered many practical suggestions

Those who were particularly helpful during Project

Mercury and Gemini include astronauts John Glenn Scott Carpenter Gordon Cooper and Jim Lovell I am also grateful for the help provided by Lieutenant Colonel John Powers Paul Haney Albert Chop Dr William Douglas Dr Stanley White Dr Carmault Jackson Dr Robert Voas First Lieutenant Dolores O Hara John Yardley Edwin Reingold Dr Kurt Debus Joe Schmitt Dr Wernher von Braun Lansing Lamont Jack King Dr Robert R Gilruth Walter Williams Richard Billings Walter Cronkite Christopher Kraft Jr George Low Charles Kohler Rene Carpenter Annie Glenn Mr and Mrs John Glenn Sr and Dr and Mrs Homer Castor

I wish especially to thank James Schefter whose extensive knowledge relating to Project Gemini was of special help

W S

AMERICAN
SPACE EXPLORATION
The First Decade

1

The Dawning of the Space Age

THE AGE of rockets is newer than the "jet age" or the "atomic age" yet it has its roots in distant history It was the ancient Chinese who were the first to employ what they called arrows of flying fire But only three modern nations were direct and charter participants in what we now call the rocket age or the age of space These were Germany, whose World War II V-1's and V-2's were developed at Hitler's great rocket base at Peenemunde, Russia, who used wartime rockets as artillery, and the United States Only these three nations were blessed with a single gifted and imaginative individual who deserves consideration as the father of rocketry' Germany's early and enthusiastic rocketeer Dr Herman Oberth developed both theory and applications The Soviet pioneer in astronautics was essentially a brilliant theorist Russian schoolteacher Konstantin Tsiolkovsky (pronounced seel kov ski) developed in the early part of this century the correct theory of rocket propulsion and flight, but he had great difficulty getting funds and enough support to engage in practical experi-

ments The American Robert Goddard who was far ahead of his time also lacked effective support but he did manage to fire a partly successful rocket as early as 1926 Prior to the 1940s Goddard s contribution was largely unrecognized but — like Tsiolkovsky — he is presently beginning to receive long overdue credit His harried and harassed career really constitutes almost the total U S rocket history prior to World War II

Robert Hutchins Goddard was born in 1883 when *Chester A Arthur was President As a boy in Worcester* Massachusetts he was frail and shy but he read avidly all the books on outer space he could find chiefly the novels of Jules Verne and H G Wells As he grew older he began to experiment By the time he was thirty two he had already acquired two basic rocket patents the maximum thrust rocket nozzle design and a method of fueling the combustion chamber As early as 1919 he suggested to the Smithsonian Institution that a multistage rocket could be sent to the moon and seven years later he actually built a crude rocket ten feet tall resembling a blowtorch Dr Goddard now a tall slim mustachioed professor set up his rocket on his Aunt Effie s farm not far from the town of Auburn Massachusetts and with the help of a three man crew lighted the fuse to the combustion chamber and then ran for cover The skele tonlike rocket blasted up with a roar then fell back The short flight before the engine malfunctioned was reminiscent of Kitty Hawk height 41 feet distance 200 feet speed 60 mph However brief it was the first liquid propelled rocket flight in the United States The

time was 1926 and no newsmen were there to report the event

For three years Goddard built and fired rockets as fast as he could mal ■ them, then one day a rocket exploded 102 feet overhead and alarmed residents of nearby Auburn People were afraid of rockets and criticized him Newspapers and magazines called him "Moony" Goddard Finally he was declared a menace to public safety and had to move his experiments elsewhere

Four years later, from the sands near Roswell New Mexico Goddard fired—long before World War II —an 85 pound rocket he named Nell Even by present standards Nell was "sophisticated" It contained many features of today s U S outer space rockets its oxidizer was liquid oxygen ("lox") fed into the combustion chamber from a pressurized tank the chamber itself was kept from burning up by the flow of propellants through and around its hollow casing—a procedure known as "curtain cooling" and a gyroscope was attached to provide stability

Nell reached a speed nearly equal to the speed of sound and rose 7500 feet above the desert Yet for all his vision and determination Goddard s efforts to interest military authorities in large-scale rocket development failed completely Until his death in 1945 the only use the military made of the talents of "Moony" Goddard was in the development of JATO bottles—jet-assisted takeoff rockets attached to airplanes—and they were quite a comedown from sophisticated Nell But Robert Goddard was primarily a scientist, not a warrior, and

in all probability it was his poor treatment at the hands of press and public that hurt him most Had newsmen reported his early experiments with tolerance and understanding the United States today might be a dozen years further along in rocket development

No reporter can hope to detail the dawn of the American age of space who didn t stand in Aunt Effie s pasture and shake Goddard s hand after that first flight in 1926 who didn t feel his blood pound as Nell blasted up for over a mile above New Mexico, who didn t watch the captured V 1 s and V-2 s and early Vikings fired from Eglin Air Force Base Florida and from the desert valley of White Sands

By the time Cape Canaveral came into the picture (it was renamed Cape Kennedy in 1964) much of the early work had already been accomplished But the Cape was the first American proving ground for the major rockets and it will someday join Kitty Hawk as a national monument

As recently as the late forties Cape Canaveral was a 15 000 acre triangle of deserted snake infested palmetto flats located in sparsely populated Brevard County half way down the Florida Atlantic coast It was so filled with snakes that Florida zoo keepers and hunters of animals for roadside tourist attractions used to drive to Cape Canaveral during heavy rains to catch snakes which escaped rising water by crawling out on the higher surfaces of the roads Inside the dense growth of palmettos swamp myrtle thyme and a scattering of palm and Australian pine trees also lived skunks, coons rabbits deer,

bobcats and a weird collection of some of the oldest reptiles on earth armadillos, horned lizards alligators and gophers (local Florida word for large, edible burrowing tortoises)

In those days the only way to reach the Cape s quiet, primitive beaches for its excellent surf fishing was to turn off the hard road leading to the lighthouse and follow a sandy rut road through the palmettos On a trip there in 1949 I recall having to race and bounce over this rut road for nearly five miles in order to dislodge a swarm of wild bees that had settled on my left headlight while I was fishing

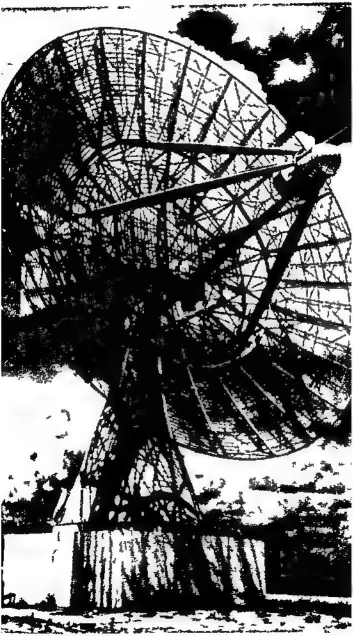
Eight miles south was the tiny, sleepy community of Cocoa Beach a place where you could buy Cokes cotton pants and Cape Canaveral shrimp The nearest thing to the rocket age and about the most complicated technical gadget you could buy was an electric space heater Virtually the only road was U S A1A, a narrow black carpet softened by the hot sun and buckled by shifting sand dunes There was little drinking water and what there was was so bad that visiting coffee drinkers complained that their coffee grains had grown stale

Five more deserted miles southward was what is now Patrick Air Force Base, then a weed studded cluster of buildings and hangars covered with peeling paint that was known as the deactivated Banana River Naval Air Station Two ancient PBM flying boats were lashed down to the ramp with frayed rope

One day, unknown to nearby residents a secret committee of officers and civilians bounced over the rut roads

at the Cape sampled the stale water at Cocoa Beach and inspected the cracked runways at Banana River Naval Air Station Their high priority assignment to turn all this into the free world s largest known firing range — a highly complex outdoor missile laboratory five thousand miles long The task must have strained the imagination of the committee swatting saltwater mosquitoes and surrounded on all sides by weeds and crusted paint What one among them really thought that in less than ten years the Cape skyline would bristle with towering gantry cranes containing sleek powerful rockets which could fly to the coast of Africa in a matter of minutes? Or that Patrick Air Force Base would become one of the most modern and complete technical installations in the nation?

Some of the problems facing the committee were staggering One of the chief reasons for selecting Cape Canaveral in the first place was the existence of a chain of islands stretching almost in a line through the Bahamas to the Lesser Antilles off the coast of South America But some of these islands were British and some were independent republics Just to get permission to put missile tracking stations there required detailed negotiation with three governments Most of the islands' natives had never heard of missiles and rockets and might panic in terror if they saw one streaking overhead or plummeting into the ocean To solve this problem it was decided to send briefing teams downrange Their job was to call the natives together show them plastic models of Matadors and other missiles and explain to them that missiles were



Missile tracking antenna

harmless if proper safety precautions were followed. But what really impressed the natives was the information that the United States would give a reward to any farmer or fisherman who found even the smallest portion of a missile and turned it over for study and analysis. For most of the natives the possibility of a reward was all the assurance they needed. Now they are so used to rockets and satellites that they hardly look up at the occasional condensation trails or orbiting satellites moving overhead.

But there were bigger problems. If the downrange tracking stations were to be really effective in following the flight of missiles and rockets, they had to be in instant touch with Cape Canaveral and with one another. Radio is unreliable over such great distances in an area noted for tropical storms and hurricanes. The answer was a thick-lided cable lowered by surface ship to the floor of the sea. It took seven years to lay the cable and cost the American taxpayers eighteen million dollars. Once it was down, operators at every station as far south as Puerto Rico could pick up the phone and talk to other stations as easily as an airline pilot can talk to his passengers through his intercom.

As it turned out, the cable had another highly useful function. In the early days island tracking stations had difficulty finding the small Matadors streaking up over the horizon. So a "chain radar" device was invented which, with the aid of the cable, enabled tracking antennae at the stations to "lock on" in advance to the exact point on the horizon where the missile would appear. For data recording purposes a method of synchronizing time

at all stations to thousandths of a second was needed, so a 'time generator' was invented which takes a signal from the Bureau of Standards and "generates" time over the submarine cable in precise fractions of seconds. And to analyze or "reduce" all this data swiftly a special computer was designed called Florida automatic computer — FLAC for short. FLAC later occupied an entire room in the new Technical Research Laboratory.

During the early and middle 1950s workers at down-range stations hacked through coral rock pine, which has wood as tough as hardwood, while in the dense brush of Cape Canaveral bulldozers gouged out a runway and cleared areas for missile assembly hangars, fuel storage and launch pads. So many thousands of workers were pouring into Cocoa Beach that many could find no housing and slept with their families in automobiles parked on the single causeway over the Indian and Banana rivers.

To prepare for a dependable water supply, twenty-four inch pipes were laid out on the shoulders of highway A1A, and a few house-hunting workers slept for a time in the sections of water pipe, using piles of newspapers for mattresses.

One morning I approached one such worker as he crawled out of his home in a concrete pipe. "Do you mind if we take your photograph?" I asked.

The unshaven worker looked me over carefully. "Look, bub," he replied after a moment. "I'm *not the least bit* proud of sleeping in this here sewer pipe." And he walked away.

Gradually the first section of the range took shape both at the Cape and at the first two island downrange stations Grand Bahama Island, called GBI 180 miles southeast, and Eleuthera Island 120 miles south of GBI The great missile and rocket base was getting ready for business

Long before radio and TV commentators could pronounce the word Canaveral properly, the first rocket — a combination of a German V-2 and a United States Army rocket called a WAC Corporal — was launched in great secrecy from a makeshift pad on the south side of the Cape A few lucky residents got a fleeting glimpse of the climbing ball of fire — a sight that was to become as familiar to the residents of Brevard County as ocean liners are to New Yorkers

Among the security cleared witnesses of this first shoot were two young engineers Homer Denius and George Shaw Both then had jobs with a large electronic company What impressed them most aside from the dramatic flight of the rocket itself was the future of Cape Canaveral As they watched the bulldozers at work their lively imaginations were among the first to foresee what was soon to become a reality a sprawling complex of buildings and launch pads comprising the nation s first massive proving ground for the attack on outer space When they returned to their company headquarters they urged that a branch office be set up at Cape Canaveral The request was refused So firm was their faith in the future of rocketry at the Cape that both

V 2 and WAC Corporal combination the first rocket ever fired from Cape Canaveral

quit their jobs mortgaged their homes rented a one room building in Melbourne Florida just south of the Cape and set up shop as specialists in missile instrumentation After the single phone was installed they hired a secretary to answer it then hit the road in their automobile to drum up some business As they traveled across the United States they frequently had to sleep in their car

Their judgment proved sound Contracts began to pour in and Radiation Inc became a multimillion dollar company with seven Florida factories near the Cape They trace the origin of their company to the launch of the 28 700 pound German V-2 rocket that rose fifteen miles and opened the curtain at Cape Canaveral

The next missile launched from the Cape was a Martin Matador, later known as the TM 71 Basically, the Matador was a pilotless jet plane Its launch from the Cape was always preceded by the high pitched whine of its Allison J 33 engine revving up Then the small forty foot silver bird angled out across the Atlantic, looking very much like the chase aircraft that followed it all the way to Grand Bahama Island, where the Matador impacted in the incredibly clear water of the Bahamas Once I flew over this splash area and through the clear and beautiful waters saw glistening fragments of twisted aluminum shining on the floor of the sea

A bigger longer range cruise missile was the SM 62 Northrup Snark which in the early days at the Cape rose from its "zero length launcher near the lighthouse with the roaring two pronged flame of its rocket boosters

A Martin Matador takes off

fanning out on both sides of the slender, winged missile After getting the Snark in the air the boosters tumbled off to plow into the Cape sand like twin motor shells, while the sixty nine foot Snark, powered by a ten thousand pound thrust Pratt and Whitney jet, angled up into the heavens for flights of three thousand to five thousand miles range At first the Snark like all missiles, had its share of explosions and freakish accidents For a time the

ocean just off the Cape was known as "the Snark infested waters of the Atlantic" But like all major U S missiles except the Navaho the Snark gradually proved its reliability Frequently its stellar-inertial guidance system was aided by ground controls which turned the missile around and brought it back to the Cape skid strip to land on its metal skids like a wing heavy aircraft, showering sparks Sometimes the same missile flew on two or more flights One of the most publicized of all Snarks was the famous runaway which seemingly with a mind of its own wandered off course defied the frantic buttons pressed to blow off its wing and stubbornly plowed over South America presumably to crash unseen somewhere in the Brazilian jungle The runaway was not explained for many months, then engineers learned that a voltage difficulty had drained power from the destruct package so that signals sent to destroy the missile were ineffective The Northrup Snark was the second aerodynamic missile — after the Matador — to be turned over to the launch crews of the Strategic Air Command In later days the successful launch of a Snark by an all military crew became a routine occurrence

The most interesting and futuristic looking missile ever to be fired from Cape Canaveral was the North American Navaho Its early difficulties quickly gave it the nickname of the Nevergo and for a while it was known jokingly as as the civil service missile It wont work and you cant fire it In appearance however, it was a handsome and imaginative combination of a huge white cigar shaped booster rocket and a graceful pig a

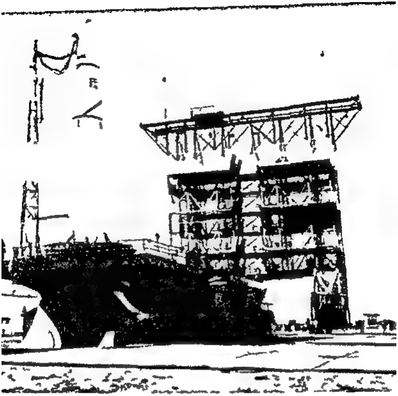
back air breathing missile The big, cumbersome booster was supposed to get the sleek Navaho up to a certain altitude and speed Then the winged missile would separate from the booster and continue on its way I never watched a Navaho countdown without feeling that when we do send men, mail and freight regularly through space, we will do it with a combination roughly resembling the basic Navaho Despite the fact that most launches ended in spectacular pyrotechnic explosions, the American intercontinental ballistic missile program received valuable information from the Navahos

In the early days at the Cape two rockets stood out as the most competitive the Army's big, husky Jupiter intermediate range ballistic missile and the Air Force's Thor For ten months these two IRBMs fired from neighboring pads ran neck and neck in a high pressure contest for selection by the Secretary of Defense as the American 1500 mile range rocket weapon The contest was so close and so intense that individual successes or failures even had an effect on the stock market, especially since two great U S companies were competing for the rich IRBM contract Chrysler Corporation, which built the early Jupiters, and Douglas Aircraft Corporation, which built the Thors Stockbrokers asked that results of Cape Canaveral test launches be flashed immediately over their teletypes

In those days we seldom had a tip off that a Thor or Jupiter was about to go Spotting a launch was strictly a matter of luck In the first five launches, Jupiter pulled into the lead with three successes compared with one

success for the Air Force The remainder were explosive failures which sometimes lighted up the entire Central Florida sky and rattled windows up to forty miles from the Cape But out of this fierce competition the United States was learning the ABCs of big time rocketry In 1957 out of eight Thors fired five were successful In 1958 out of twenty Thors or Thor Ables fired ten were 100 per cent successful five were more than 50 per cent successful four less than 50 per cent and one a failure We had started serious rocketry some four years later than the Russians and no matter how bad the explosions above Cape Canaveral looked we were making progress of a sort that would be beneficially reflected in all our missile programs to follow The Army had set the ballis tic pace with its reliable short range Redstone rocket which from the beginning roared up from the Cape with punctual dependability When we wanted to show our friends what a rocket launch looked like it was always safe to pick a Redstone because it was invariably on time and nine times out of ten successful

Another early Cape missile which steadily improved in reliability was the Boeing Bomarc a long range antiair craft and antimissile missile With its short triangular wings the forty seven foot Bomarc looked like a pilot less supersonic fighter Unlike other air breathing aero dynamic missiles such as Matador Mace and Snark Bomarc was designed to be launched vertically with a rocket booster Once it was high in the air its two ram jets took over as the swift black red and yellow missile homed on its target



The mighty Thor

In one of its first flights Bomarc created a Cape sensation by cutting several flips in the air before it splashed back against the ground to disintegrate in a skidding ball of fire The cause of the malfunction was faulty aerodynamics, long since corrected The graceful Bomarc was soon rising regularly from its launch area near the Cape lighthouse Later Bomarcs were housed in small gray hangars whose roofs opened suddenly to allow the Bo

marc to rise erect and blast off Once a swarm of wild bees built a nest in the hangar roof and successfully survived a series of launches, to everyone's amazement

Targets of the Bomarcs were high flying radio controlled B-17 'drones" with cameras mounted in the wings It is an eerie sensation to look at a film of an on coming Bomarc The twisting, hunting missile grows from a speck to a winged bullet in a matter of seconds then at its closest point ejects a small puff of smoke to indicate the point at which a nuclear blast would be detonated When important Congressmen would come to the Cape and see the puff of smoke they invariably cried 'But it missed the target' Air Force officers spent many long minutes patiently explaining what should have been obvious — with a nuclear blast it is not necessary for the Bomarc to hit the target By the simple law of averages however, it seemed that sooner or later one of the Bomarcs would actually hit the Flying Fortress drone Yet for months all the drones came back to a radio controlled landing at Patrick Air Force Base Then, one day in 1958, the inevitable happened a Bomarc plowed through the tail section of a B 17 Unfortunately, what could have been a great film was also destroyed More refined Bomarcs were later launched from the Cape in pairs by a button pushed in Kingston New York over fifteen hundred miles away in a significant test of our ability to detect and destroy an approaching enemy by using Bomarcs in conjunction with giant IBM digital computers

One of the most accurate early records of American

missile progress was kept by Louis Berger and his unique crew of missile-recovery specialists When a bird fell back into the ocean it was Berger s job to locate it, haul it up from the ocean floor and bring it back to the Cape for study and analysis

To recover Matadors and Snarks in the early days Berger used forty two foot torpedo retrievers (AVRs) but business became so brisk that he and his deep sea divers switched to a fleet of three ninety-nine ton Army utility boats Before each flight Berger dispatched one boat with a captain, mate, engineer and two experienced divers to a position several miles off the Cape They kept up with the countdown by radio, and killed time by reviewing their notes on the characteristics of the particular rocket they were waiting for or checking out their diving equipment

If the missile failed in early flight, the boat charged quickly to the point of impact The crew searched for a propellant slick dye markers or bubbles If signs of the missile were sighted, the captain computed current and tide effects and sent over a diver In the algae-filled waters around Cape Canaveral, hunting for a missile, as deep-sea diver Vernon Neally put it, was like trying to find something in a pitch black room The missile hulks on the ocean floor were potentially dangerous If poisonous propellants were still aboard they could stream off in the water and cause painful skin rashes on contact If explosives for destroying the missile were still attached they first had to be disarmed or detonated Divers walking about the dark ocean floor were rotated every twenty

minutes until contact was made Then a cable was attached and the diver sometimes straddled the battered missile and rode it to the top

If a missile remained over two days on the ocean floor still another hazard developed Shark barracuda and octopus sometimes moved into the empty shell and had to be flushed before recovery operations could begin One diver found five small octopuses in a single missile Divers never carried spear guns because blood would attract sharks

To become proficient in their highly specialized work Lou Berger s security cleared divers attended missile briefings learned where stages are joined where holes were available for attaching cables where the destruct package was located and what type of fuel and oxidizers were aboard Sometimes they made recommendations on the location of dye markers

The work the divers most preferred was recovery in the crystal clear waters of downrange impact areas Here they were launched over the side in a small outboard While one man ran the motor the diver was towed behind on an underwater sea sled By manipulating vanes the diver could move up and down or sideways as he searched for the missile

"My divers are the greatest bragged Lou Berger ' To get the job done they have sometimes worked at a depth of a hundred fathoms

The job they did was the recovery of one or more of the following U.S missiles Matador Snark Navaho Bomarc Atlas, Redstone Jupiter Thor Polaris and

Vanguard The dollar value of a single missile like Atlas was over a million but it wasn t the worth of the battered twisted metal that made missile recovery worth while It was the information on the cause of failure, which often led to successful modification

Said Berger proudly, So far, we ve found everything we ve looked for '

At the same time that Berger and his crew were getting more experience in their highly specialized occupation, Cape Canaveral itself was constantly expanding The south beach was now lined with towers gantrys and hangars used in launching Thors Jupiters Redstones, Matadors, Snarks Bomarcs and various smaller experimental missiles Meanwhile the missile assembly area near the Banana River was spreading out like a small industrial city, complete with the central control electronic nerve center, impact predictors, tracking antennae and cafeterias and fire stations The stage was now set for major challenges in the conquest of space

2

On the Pad—the Mighty Atlas

IN 1956 AND EARLY 1957, the skyline of Cape Canaveral was altered by the appearance of several massive red and white service towers along the north beach A persistent rumor had it that these giant candy-striped structures the largest on the Cape, were erected to prepare the mighty ICBM, the ocean spanning Atlas, for launching

In the spring of 1957 few of us had any idea what an Atlas looked like Unlike the open" NASA flights of today when newsmen are permitted to enter the Cape and millions can witness launches through the close up lens of a TV camera U S rocket launches in the fifties were highly secret affairs There was no such thing as NASA, or any other civilian space agency, all rockets — many of which were military weapons — were under the tight control of the Army the Navy and the Air Force The contractor responsible for running the rocket range was Pan American World Airways, who ringed the base with security police There were no press releases no TV coverage and no briefings Severe penalties

existed for those who even discussed generally our rocket programs

We knew only that our first ICBM was being built by the astronautics division of Convair in a huge plant in San Diego, California, and that it was supposed to fly over five thousand miles We knew that the Atlas, like Jupiter and Thor, was a ballistics missile — which meant that after being guided to a certain point in the sky by land-based equipment, it coasted on its own for the remainder of its flight In some respects the first or 'aimed' portion of the flight was up the middle of an invisible electronic barrel Then, at the point high above the atmosphere when all ground guidance ceased the missile was free to streak on to its target like a bullet If it were properly aimed in the first portion of its flight it would hit where it was supposed to

That spring the canvas shrouded, top secret Atlas was rolled out of the San Diego factory and transported by truck and trailer across the continent to its assembly hangar at Cape Canaveral But none of us had seen it until, one afternoon in May, another reporter and I — feeling uneasy and very much like some sort of spies — drove the thirty miles around the Cape and Banana River to the nearly deserted north shore When we saw the Pan American police at the north security gate, we backed up pulled off the main road and parked on a rut road in the sand dunes about 150 yards outside the high security fence Whenever the guards glanced in our direction, we ducked On the other side of the barbed-wire-

topped fence, about two miles farther down the beach we could see two tall squarish service towers I turned my binoculars first on the nearest tower It was plainly empty I could see blue sky through its latticework But the center portion of the second tower appeared mysteriously solid then the sun came out from behind a cloud and I caught a tall glint of silver inside the steel girders of the tower I was astounded the Atlas looked nearly as tall as the tower itself and as big around as a tank car This was a great rocket and I couldn't wait to see its first flight

During the next few weeks I or one of my friends checked the tower through glasses almost every day But it was not until the last week in May that we finally learned through a private source that launch time was 8 A M, Friday, June 7 The three other reporters and I kept the date strictly to ourselves In those days most of us felt like intruders on military security every time we studied the silhouette of the Cape and we were as determined to protect the date of the launch as we were to see that first historic flight

But because of both bad weather and trouble with the missile the shoot was held up over the weekend At midnight on Monday June 16 1957 we noticed Air Force and company cars heading inside the Cape We knew these carried some of the hundred and fifty people directly concerned with the launch Air Force project officers and personnel from Convair Rocketdyne (which built the engine), General Electric (which built the guidance system) A C Spark Plug and American

Atlas   as big around as a tank car

Bosch Arma Corporation, as well as the firemen doctors and ambulance crews who were stationed near the launch pad The countdown began during the night

But the "secret of the launch date inevitably leaked into the community, at 9 45 the next morning I counted fifteen people including five women standing on a motel roof south of the launching area all looking toward the Cape which jutted out into the Atlantic like a broad flat pier The big search radar dish on the Cape was rotating and the giant orange balloon used to warn fishermen was hoisted to the top of a ninety foot pole Earlier I had driven up to Port Canaveral harbor and watched two red and white Air Force crash boats back slowly out of their berths and head out to sea Now the boats were patrolling the waters off the Cape alert to warn boats to stay out of the five mile diameter danger area All the signs pointed to an imminent rocket launch But at ten o clock a drizzling rain blew in over the sea crowds on the beaches and roofs ran for cover and spirits sank with the gloomy weather

After lunch however the skies began to clear The instant the spreading rays of the sun touched the Cape I aimed my binoculars toward pad 14 seven miles away and there standing alone and majestically erect, was Atlas.

During the squall the tower had rolled back to a transfer table that had in turn carried the tower on giant tracks a safe distance away Now the Atlas was making its dramatic premiere And it had a growing audience Somehow the word had filtered through the community

that Atlas was ready Carloads of men, women and children now poured out on the hard coquina sand of Cocoa Beach By two o'clock the few observers who knew exactly where to look could see a spume of lox vapor streaming off near the top of the rocket As the rocket got colder it also whitened with a rime of frost and was much easier to see Now the gray clouds overhead separated as if on command, forming a wide blue corridor just above Atlas

I had selected the spot where there were the most people because I wanted to report the reaction of the American public to the shoot, but now as the rocket launch appeared only minutes away I became concerned that a *Life* photographer farther up the beach might not see the rocket through the haze of the surf To alert the photographer I decided to take a gamble I got in my car and started slowly down the beach, watching the Cape through the windshield The car had moved only a hundred yards when I saw a blast of pink orange light straight ahead I slammed on the brakes, grabbed my binoculars and leaped out Atlas was already rising A jet of brilliant white light was floating upward above a boiling mass of smoke and steam Bathers and birdwatchers around me cheered 'There she goes' 'She's going up'' 'Keep going' ' And keep going Atlas did, rising those first thirty seconds straight and true It was a sight to remember I could hardly keep my binoculars steady Then suddenly, one of the twin exhaust flames began to lengthen and grow jagged Along the edges of the flame I could see a growing mass of ugly black smoke Some-

thing was wrong The flame licked more jaggedly the smoke grew You could see the rocket actually slowing down The mighty Atlas began to wobble and stray off course leaving a curving wake of black smoke like a burning plane The rocket fell off to the right then was engulfed by a great red glob of flame boiling up into black smoke It looked as if a whole tank car of gasoline were burning high in the sky Atlas was dying A long splinter of the missile was now falling toward the sea licking flame at one end Then this too exploded with a small white flash

The crowd on the beach was stunned And now the sound reached us in a vocal and ironic echo of the tragedy First we heard the triumphant roar of ascent then the muffled explosion of the ruptured propellants and finally the sharp crack of the explosion when the range safety officer Major Moody pressed the destruct button that ended Atlas the First forever

As pieces of shattered metal floated down onto the Cape and into the sea the wind brought us still another echo of the disaster the bittersweet acrid smell of the explosion something akin to the smell of burned kerosene, mingled with the electric smell of ozone The crowd walked away silently

Thus after fifty five seconds of flight ended the first Atlas because one of its two booster engines malfunctioned It was a spectacular visual failure but a flight which as an Atlas engineer told me later gave us ninety per cent of the crucial information we wanted to know on this flight We found out for one thing she s a tough

old bird Before she broke up she held up through some high-stress maneuvers We re satisfied we ll get her up there It's the only rocket in history that s gotten off the launch pad on its first scheduled flight

Three months later on September 25, reporters and birdwatchers again assembled on the beach The day was overcast and gloomy, with occasional rain There was no blue corridor this time to mislead us with a false good omen This time Atlas also rose true A fifteen knot breeze was blowing off the ocean and I was startled to see the huge Atlas drifting westward in the breeze as a plane is blown in a crosswind It rose for over a mile then — as before — began trailing a long uneven tail of red flame Atlas suddenly tipped violently to the east, continued to coast upward on its side, then righted itself in a sort of barrel roll before it lost all control and was destroyed as it arched over the sea Its shattered and smoking remains plummeted down through a cloud layer, reappeared briefly, then were lost in the darkening haze over the ocean

Twice our great intercontinental ballistic missile had faltered in full flight and missilemen were determined to find out why According to engineers there is only one failure possible in a missile flight and that is what they call a 'blank tape ' This means that from an engineering standpoint they are making progress as long as information on temperatures propellant pressures and other vital readings are telemetered — or radioed — to earth during flight This coded information appears in the form of punch marks on rolls and rolls of pink tape After the

second Atlas for instance engineers received on punched tape a total of 32 000 linear feet of valuable information They spent a total of 570 continuous man hours analyzing these tapes merely for what is known as quick look' data In this process in the Technical Laboratory at Patrick Air Force Base, one girl stenographer fainted and two others became so exhausted they had to be replaced But Atlas men knew that somewhere in those reams of pink tape lay some important answers to important questions Their job was to find those answers and turn them into a better Atlas This they did, over the period of the next three months

On December 17, two improved Atlases stood in gantry cranes on the Cape Momentous world political events were in the making Russia had launched Sputnik and a flood of criticism of the U S missile program had followed In Paris NATO was in session and President Eisenhower was attending The date was important for another reason December 17 was the fifty fourth anniversary of the day the Wright brothers had flown the first power driven plane at Kitty Hawk The feeling at Cape Canaveral was that one of these two missiles had to go — and keep on going

Tuesday morning dawned gray and foreboding The original group of four reporters had now grown to forty on the north beach and about twelve south of the Cape where most of the crowd had assembled At 9 13 A M lox venting began then abruptly stopped After a forty-five-minute delay due to faulty telemetry equipment the

count resumed as a series of rain squalls swept in from the northeast Throughout the rain which caused another forty five minute hold the forty men who actually launched Atlas remained buttoned up in the massive blockhouse 750 feet from the pad The reinforced concrete walls of the blockhouse averaged eight feet in thickness and together with a ten foot layer of sand on top were designed to withstand a blast equivalent to fifty thousand pounds of TNT exploded at fifty feet Every major missile except Atlas at one time or another had blown up on the pad The rain not only increased the danger of explosion but also added pounds of ice to the thin sides of the subfreezing oxidizer tanks

At T minus zero test conductor Tommy Zannes flipped the red switch starting the automatic launch sequencer Precisely at 1. 38 P M flame spouted at the base As planned the rocket did not rise immediately but was held in place by powerful yellow steel jaws until it reached maximum thrust During this perilous interval one of the disconnected fuel lubricating lines fell into the hot section of the pad spilling its oil and sending up a dense cloud of black smoke She s blowing up!" someone shouted but almost immediately the yellow jaws flew open and the rocket began to rise shedding hundreds of pounds of ice slivers which burned incandescent as they fell through the flame It climbed for thirteen thousand feet disappearing in a rain cloud The rocket reappeared a half minute later, then bored on into another cloud layer Then for the third time — this time at jet

plane altitude — Atlas appeared again climbing steadily as it spun out a long white contrail in the brilliant sun light above the clouds

She s going to make it' a man shouted And make it she did The sound of her success died away evenly and gradually sweet music to an engineer She landed two hundred miles beyond the spot four hundred miles away she was aimed for — splashing into the Atlantic just north of Grand Turk Island in the Caicos group

That night Henri Landwirth manager of the old Star lite Motel which was a sort of unofficial headquarters for missilemen placed a huge sign in the restaurant CON GRATULATIONS CONVAIR AND AIR FORCE WE KNEW YOU COULD MANAGE IT

But Atlas required many more test flights Once more in 1957 and eleven times in 1958 the mighty ICBM blasted up from one of its four launch pads with varying degrees of success in flights deliberately programmed for about half its full ICBM range

Then just after midnight one beautiful November night a handful of newsmen saw Atlas number 15 lift off the pad arch serenely over the full moon and barrel like a meteor through the stratosphere toward the southeast After nearly five minutes we could still see the tiny glow of its sustainer engine just below the constellation Orion Then at T plus 294 seconds the tiny star winked out and Atlas was on its first long ride for full range After about twenty eight minutes its nose cone streaked down near Ascension Island in the South Atlantic at better than sixteen thousand miles per hour When it finally hit the

ocean it was over 6300 statute miles from Cape Canaveral

That night at the Convair celebration one of the heroes was Bob Shotwell the man who pressed the button The word passed around that Shotwell shot well! The mighty Atlas had proved to the whole world what its designer intended

In missileman terms, if a thing works once presumably ways can be found to be sure it works repeatedly Such performance is called reliability and all missiles and rockets must go through repeated tests before reliability is firmly established During the months that followed Atlas s first great full range flight one of the men chiefly responsible for building reliability into our first ICBM was Byron Gordon MacNabb known affectionately around Cape Canaveral as Mr Mac or Mr Atlas

B G MacNabb was a short dynamic missileman who started in Navy missiles and by dint of his qualities of leadership came into Cape Canaveral in the early days to head the Atlas test program Housing was so scarce that one of his first extracurricular jobs was to boss a major housing project known as Convair Cove "When I hire an engineer' he told me one day 'I want to be able to give him a decent place to stay' So Mr Mac had to race in his green Convair hard hat between the Atlas launch pads and the muddy streets in Cocoa Beach where houses were being erected for the Convair team

The first time I met Mr Mac was after the first dramatic Atlas explosion Because *Time* and *Life* magazines for which I worked had referred to this shot as something less than successful, devoted Atlas man B G Mac-

Nabb had given me an eloquent and prolonged dressing down that lasted over an hour Throughout the eloquent comeuppance he was giving me the thought constantly flashed through my mind that the United States was lucky indeed to have a man so spirited dedicated and knowledgeable in charge of our ICBM tests It was impossible to get mad at him He shouted He waved his arms He ranted and he raved but behind it all was his undeniable faith in Atlas and in the U.S missile program

The next day around the swimming pool at the Starlite Motel Mr Mac had calmed down considerably Between dips in the pool we talked quietly about our hopes for U S rocketry and within a matter of a few days Mr Mac and I became firm friends I quickly discovered him to be one of the few so called specialists at Cape Canaveral who also had an eye out for the big picture who followed and attempted to understand the whole complex fabric of U S space acceleration By and large the men who saw the big picture among the Cape s concentration of limited specialists were as rare as poets at MIT But Mr Mac along with General Yates and George Shaw of Radiation, Inc was such a man

Eight years after the first flight of the mighty Atlas, the big bird was still performing magnificently and so was the man who helped put it up there During the mid sixties when I visited the Cape I sometimes stayed at Mr Mac s house or joined his wife Iris and Betsy and Walter Cronkite for dinner Mr Mac never changed — either in appearance or in his devotion to rockets — and he was *just as feisty as ever*

3

Vanguard or Rearguard?

THE DISASTERS and eventual triumph of the U S Vanguard is one of the most dramatic stories of the early trials of U S rocketmen In late 1956—before Sputnik—United States participation in space was chiefly the concern of a small core of professional missilemen scattered from California to Cape Canaveral The public at large and educators in particular had not yet been aroused over our slow scientific progress Officials in Washington had made only token efforts to organize and direct our conquest of space It was true President Eisenhower had announced on July 29, 1955, that the United States would attempt to launch a series of small satellites during the International Geophysical Year which began in July 1957, but this was a small and limited program indeed compared with what we now know the Russians had undertaken And the single rocket upon which our satellite hopes then depended was the very smallest that could loft a twenty pound satellite into orbit—if all went well The rocket, which was optimistically named Vanguard had no safety margin of power If each of its

three engines ignited properly and raced at full throttle so to speak we could just barely reach the required eighteen thousand mph speed at three miles altitude In addition the plumbing and wiring supporting the combustion chambers were complex beyond measure partly because of the slender tube they were jammed into

Just how complex they were and how slim was the margin of power were known to only a handful of Navy and Martin Company scientists and specialists most of whom had spent months in the hot desert at White Sands testing the Viking rocket upon which the complicated Vanguard design was based At the time little or nothing of Vanguard's details had been made generally public and those of us at Cape Canaveral who were trying to get the facts collected our information from occasional technical speeches or articles in scientific publications

Among the reporters who enthusiastically read everything they could find on missiles and rockets was Jim Halbe of the *Orlando Sentinel* my backup man that is he covered stories for me when I was out of town One day in December 1956 Halbe was delighted to get a telephone tip from a friend that a Viking rocket called TV Zero the first of the Vanguard test vehicles was about to be fired from the Cape Sensing a rare moment of early rocket history Halbe drove over to the Cape on Pearl Harbor Day climbed the mast of a ship in Port Canaveral harbor waited until dark then furtively focused his binoculars on the well lighted gantry on pad 18 A For five shivering hours he kept a log of everything

he saw, in his excitement at getting an exclusive eyewitness story he even noted the fact that a shooting star blazed across the heavens at precisely 8 04 P M

Just after midnight his patience was rewarded as the forty-two foot Viking blasted up from the pad and traced a long serene arc of star colored flame across the sky When Halbe climbed down from that ship's mast he had a story in his pocket that went around the world At last the United States was taking definite steps toward launching an earth satellite

By a fortunate coincidence I was downrange in the Bahamas during the shoot, on an assignment for *Life* to write an article on activities at the fast-rising U S space port The day after the shoot I landed at our missile observation station on Grand Bahama Island where the base commander gave me a tour of the brand-new Vanguard tracking installations Returning on the plane, I talked to two technicians who told me just how they had tracked the rocket Back at Cape Canaveral one of the men invited me to his home where for two hours I discussed the shoot with his three Vanguard roommates I learned for the first time that the rocket actually carried a small round test satellite with antennae improvised from metallic measuring tape that the countdown had been delayed because a ship was temporarily in the range corridor, and many other details of the shoot

I copied down these facts with the certain knowledge that Halbe and I together had one of the first accurate and comprehensive rocket launch stories There was no hesitancy on the part of my sources They knew as I did,

that Vanguard was not a military weapon but a scientific research vehicle It was as annoying to them as it was to me that a classification of confidential had been placed on their purely scientific project They were proud of their research rocket and wanted to let the world know the test had been a great success But when the resulting article was presented to the Pentagon for security clearance the Pentagon turned thumbs down on it Said one officer over the phone It would be embarrassing to us if people found out you could acquire that kind of information about what goes on at Cape Canaveral

The news blackout gradually reached the point where Vanguard was in actual effect far more secret than any of our rocket weapons During the next year as further test vehicles were fired enough leaked through to establish that the test program was on schedule and — so far — successful

Then in one electrifying announcement on October 4 1957 Vanguard's potential glory received a world shaking jolt Russia had launched not just a tiny satellite but a 184 pound artificial moon The claim couldn't be disputed because all around the globe the course of the satellite could be followed It was a marvelous and thought provoking achievement Immediately the pressure on Vanguard's crew multiplied manyfold Overnight Vanguard became a symbol not of scientific research but of our national image and prestige The United States needed — and needed desperately — an answer even a tiny symbolic one to Sputnik

It was against this background that a Vanguard rocket called TV 3 (for test vehicle three) was readied on the pad almost exactly a year after the launch of TV-Zero In the nose of the seventy two foot rocket was a tiny pretender to the sacrosanctum of space, a 3 2-pound shot-put 6 4 inches in diameter The secrecy wraps were suddenly thrown aside For four hours J Paul Walsh, deputy director of the project and Herschel Schooley of the Department of Defense gave a detailed briefing to over a hundred newsmen in the base theater at Patrick Air Force Base On stage was a gleaming break away model of the rocket and a full scale replica of the twenty one-inch satellite which Vanguard was eventually expected to launch

Newsmen were not allowed inside the Cape, but when the countdown began, status reports were relayed to reporters and photographers assembled in the sand dunes just south of the Cape In the damp, cold Florida night the long countdown delays contributed to a weird and frustrating spectacle The Air Force had moved in two blue flatbed trucks and atop these were ranks of movie and still camera tripods Nearby in the sand Hank Walker and the *Life* magazine team had erected a huge Big Bertha camera lens over six feet long it looked like a cannon pointing toward pad 18-A just three miles away To acquire extra elevation one photographer had rented a huge moving van which he backed out on the sand as a base for his camera Driftwood was precious and we collected all of it we could find for firewood During the

long nights newsmen huddled around the fires eating sandwiches drinking beer and coffee Sometimes we sang songs but our eyes never wandered far from the candy striped Vanguard gantry which glowed like a jeweled skyscraper just across the mouth of the harbor In one night Lieutenant Colonel Sid Spear and Major Ken Grine between them had over a hundred telephone calls from the press TV and radio reporters

Aside from what the three day delay did for the patient and harassed launch crews it had an unfortunate and basically unpredictable effect on the American public Each morning and evening all across the land the headlines blazoned VANGUARD IN COUNTDOWN MOON ROCKET DELAYED U S MOON NOW READY SATELLITE LAUNCH POSTPONED AGAIN The information policy, formerly so strict was now suffering by contrast because of the appetite of a news hungry public Any idle eyes and thoughts that hadn t been concerned with satellite launches were now focused irrevocably on a slender and delicate rocket under the throes of a difficult countdown at Cape Canaveral It was as if the national emblem were being hoisted there and everyone wanted reassurance that it would reach the top of the pole

The final countdown began Friday December 6 1957 at I A M Just before eleven in the morning the gantry moved back and lox vapor could be seen streaming off Vanguard near the top of the dark green first stage The two bottom stages glistened in the morning sun gradually the first stage acquired a thin coating of ice crystals At 11 44 A M the rocket s umbilical cords

dropped away and bounced off the catch net Thirty seconds later a spurt of flame appeared at the base For two seconds everything appeared normal The rocket actually began to rise Suddenly a tongue of orange flame darted out of the base briefly climbed the west side of Vanguard then fanned out toward the ocean side of the rocket and blossomed immediately into a massive, roiling ball of red fire and black smoke For ten seconds the rocket was engulfed in a fast spreading fireball Vanguard fell straight down from its acquired elevation of three feet its base struck its own launch ring The blow dislodged its pointed nose fairing and the tiny satellite fell to the ground Now the entire rocket toppled into its nest of fire, which expanded into a roaring mass of flame as high as a seven story building

Overhead an adventuresome CAP pilot screamed into his microphone I don t see our satellite rocket — smoke and flame is spreading over the ground — something has gone wrong I don t see our rocket Something has happened "

What had happened was that America s first satellite was now plaintively transmitting its radio signal on 108 megacycles not from the serenity of the heavens but from the earthbound sands of Cape Canaveral Nearby the remains of TV-3 were smoldering and warping as the dying flame licked at the shell of a national aspiration The first Vanguard had seemingly ended in a miserable disaster

During the next week the nation s frustration was variously recorded in the press To some, Vanguard s failure

was an indictment of the entire U S missile program Scapegoats were needed and the most immediate ones handy were Herschel Schooley and his cohorts who had provided such basically harmless information as count down status A part of the nation s press which had been screaming for months for more information on our rocket programs demanded the scalps of the very people respon sible for that information The entire Vanguard program was suspect The American flag had faltered and fallen before it was well up the mast

It seemed difficult to understand at the time but in the cold light of history the conspicuous Vanguard failure actually did more for the American space effort than a success would have done After the 184 pound Sputnik, a single success with a 3 2 pound satellite would have been a minor triumph at most

A failure on the other hand forcefully reminded pub lic and Congress alike that we needed more money bet ter scientific education more concerted effort in missiles and rockets This was the outward effect and it took hold almost immediately in increased budget and space projects To the hard core of professional missilemen the Vanguard failure was something entirely different merely an expression of the law of averages in rocket re search Missilemen realized that no known rocket in his tory — not even the German V 1 s and V 2 s — had ever succeeded in the first attempt They naturally regretted the conspicuous failure but to them there was nothing unduly alarming about the explosion heard round the world a certain percentage of rockets were bound to fail

during early development — at least one out of three While the nation was learning this basic fact the hard way, professional missilemen went right on getting other rockets ready They knew without a doubt that some of these rockets — eventually almost all of them — would succeed

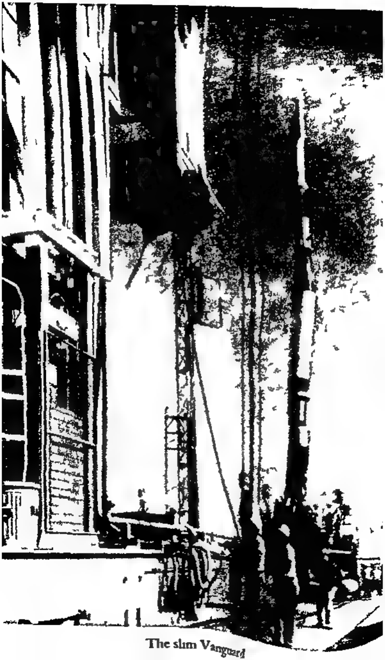
The Vanguard launch crew now had to live with the awesome memory of the crimson glow that had penetrated their periscope windows and stained the blockhouse walls with tragedy They were discouraged but not defeated They cleaned up the debris repaired their launch platform and went back to work Spurring them on was the knowledge that the Army had also been given permission to try to launch a satellite and a big Army Jupiter C was already being adapted for the task Who would be the first to launch an American satellite, the Army or the Navy?

TV-3 backup was moved to the pad during one of the coldest Florida Januarys on record To avoid another public buildup newsmen were given confidential briefings on Vanguard's schedule with the understanding that they would print nothing about an impending shoot until "there is fire under the bird" As part of the new security arrangement the press could now go inside the Cape and watch launches from a rooftop tower about a mile and a half from the southern launch pads Fourteen telephones were provided plus a Pan American snack wagon to furnish coffee and sandwiches during the long cold nights

It was here one night that we got our first close look at

a U S rocket The towers with their surrounding galaxy of ground lights looked like island cities separated by the dark wastes of palmetto scrub Along the south shore the Vanguard complex seemed small Compared with the ponderous bulk of ICBM and IRBM launch facilities the Vanguard tower was far from imposing It differed from other towers mainly in a heavy red crane which angled up from its eighth and top story Because of the crane the Vanguard tower appeared to hunch protectively around the bird concealing it in a mechanical maze of red and white steel latticework Through powerful binoculars small frenetic figures could be seen in the tower itself climbing steep open stairways sliding down poles fireman fashion or scurrying back and forth on the various decks There was an air of desperation and drama as TV-3 backup was groomed for flight

Frosty nights moved into rainy lead colored dawns and still the bird did not fly Delays were mounting un accountably Three times the mournful warning horn blasted its awesome foggy throated voice across the Cape and three times radiomen taped their introduction only to be frustrated again as the count was postponed or scrubbed In between counts newsmen played poker in the cold windswept tower or rode the bumpy Air Force buses back to their quarters Vanguard once got within nine minutes of launch it was scrubbed Then it got within four and a half minutes before bad weather called off the shoot On the next attempt a strange thing happened About eight o clock at night the count was halted at an agonizing T minus 22 seconds — less than half a minute



The slim Vanguard

from launch A newsman shouted and we looked up in the dark sky to see the Sputnik II rocket casing slowly coursing southward across the heavens The rocket that now carried a dead Russian dog was slowly tumbling It glowed eerily three times then slowly faded It was like a flaunting challenge to the loxed up ice encrusted but still stymied Vanguard Said one newsman just after Sputnik faded in the southern sky Vanguard is jinxed for sure, now It was a grim prophecy

During the next few days Vanguard burned two men with acid Propellant leaks in the second stage multiplied So many spare parts were pulled off another Vanguard in the hangar that the spare had to be shipped back to the factory in Baltimore Blockhouse personnel reported to work in red shirts because in the old days at White Sands when things went well, someone recalled there had been a lot of red shirts in the blockhouse Shivering photographers no longer checked their cameras every few minutes, instead they played poker even after Vanguard was loxing But at two-thirty one morning the count had progressed to within three minutes of launch and the long card game broke up Three minutes later Vanguard spurted flame and began to rise But forty seconds later when normally the rocket would have programmed over the ocean and the blockhouse doors would have been opened the blockhouse doors remained shut The rocket was not programming properly it was still going straight up over the Cape Said the range safety officer at T plus 50 seconds I think I'll have to blow her The rocket was going so straight up that some photographers

tipped over their tripods trying to stay with it The rising bulb of white light now began to wobble, then it gyrated through a small loop, throwing off to the right another chunk of light trailing smoke Both burning fragments bobbed and weaved crazily in the sky, began to fall back toward the ocean just off the tip of the Cape The main stage was roaring down still under thrust accelerating Now both lights suddenly went out, a few seconds later the roaring sound died abruptly What was left of TV-3 backup was falling invisible and silent, through the night sky Another Vanguard had failed The stunned crew in the blockhouse were not allowed to leave for nearly an hour There might still be sharp pieces of metal floating down that could slice off a man s head

The next day missile recovery specialist Lou Berger took his boat out and one of his divers found the unexploded third stage at a depth of twelve feet straddled it and rode it to the surface The battered and twisted first stage was recovered from the ocean floor the following Wednesday The satellite itself, or what was left of it was never found

Traditionally at Cape Canaveral when missiles are in trouble puns and jibes are heaped upon them Vanguard now became known as seventy two feet of minor technical difficulties,' "a solid monument," "a Navy anchor" Jokesters said it was an oak tree whose roots had grown into the ground, suggested that the only way the Navy could launch it was with giant rubber bands or through the muzzle of a sixteen-inch naval gun

Crew morale was at its lowest since the program began

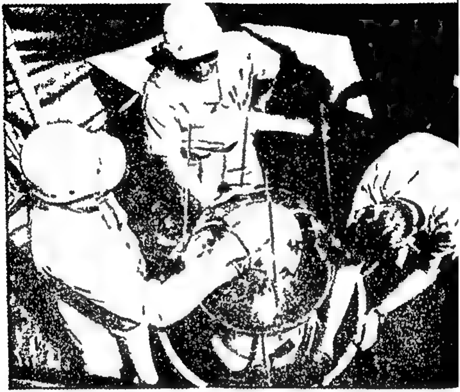
even lower than on January 31 when the Army had launched its magnificent Explorer I in orbit to establish firmly the first American satellite

The trouble plagued Vanguard crew clenched their teeth and put TV 4 on the pad The launch attempt was set for St Patrick s Day so losing no opportunity to buy a little luck many project personnel showed up at the blockhouse wearing green shirts In addition crewmen had stenciled HAVE BALL, WILL ORBIT and LOVE LIFTED ME on the side of the rocket A St Christopher medal was wired to the guidance system Waiting nearby in the press tower we watched the morning star and a thin slice of moon in the brightening eastern sky Then the sun rose behind a murky cloud bank and glinted off the slender Vanguard standing alone on its pad The countdown progressed steadily There was a minor hold at 7 04 when telemetering and DOVAP (Doppler velocity and position) were shifted from external to internal power Then the count picked up again continued to T minus zero Now a marvelous process was building life into the rocket Hydrogen peroxide activated a tiny efficient steam generator The steam in turn forced the two powerful propellants — one a fuel called UDMH (unsymmetrical diamethyl hydrazine) and the other liquid oxygen — into the rugged regenerative (self-cooling) combustion chamber Once ignited the hot burning gases poured out the constricted nozzle Jinxed no longer the graceful rocket lifted majestically in the morning sun The roar of ascent reverberated across the Cape like the thunder of triumph At T plus 70 seconds a

white vapor trail spun out which was quickly whipped into loops and spirals by erratic winds aloft Speeding on, the rocket left its vapor pretzel far behind We clearly saw main stage burnout at 140 seconds Vanguard was finally on its way

We learned later that the launch time had been set deliberately to avoid the first outer space traffic problem Explorer was due to pass overhead between 6 50 and 7 10 and launch was set just after 7 10 A M to avoid a possible radio interference problem Three hours later we met with the elated Vanguard team Said happy Irishman Paul Walsh First reports from Grand Turk indicated altitude was good and velocity more than adequate The first station to report positive orbit was San Diego The Philippines had actually tracked it first but word didn t get through to us in time' Walsh straining to hold back his personal elation over a successful orbit also said, "We take this pretty calm, maybe we re old pros' But that night at the Vanguard celebration party, old pro' Walsh sang every Irish song in the books was the life of the party and got himself thrown into the swimming pool along with his friend, tall dignified Bob Schlecter — Bob had expected a sousing and brought extra clothes in his station wagon

I learned that night that President Eisenhower s personal aide Captain Peter Aurand, had observed the shoot in order to report back to the President With Walsh he had stationed himself 1800 feet from the rocket at a faded blue Air Force van At one point he smilingly pulled a horseshoe out of his pocket This shoe came



Installing a satellite atop Vanguard

from my daughter s horse he told Walsh and the time has come to use it Whereupon he spit on the horseshoe and threw it over his shoulder Later after the perfect launch, he raced out in the sand located the horseshoe and passed it around to be kissed for good luck Now I ve got something to keep he said

Vanguard thereafter continued to have difficulties, but nothing could dull the luster of that great St Patrick s

Day The light 3 2 pound satellite could not compare with Sputnik II s 1120 pounds or even with the Army s thirty pounds, but it had accomplished two things that topped them all its maximum height, or apogee was a new record and its expected time in orbit was hundreds of years instead of mere months The disaster of December 6, 1957 had awakened a sleeping nation and the triumph of St Patrick s Day 1958 had made the nation proud

4

The Explorers—a Miracle from Alabama

WHILE THE VANGUARD launch crew tried desperately to get TV 3 backup off the pad another group of men worked steadily at the nearby Army complex Their mission was roughly the same to launch a satellite which would orbit the earth and send back data on outer space The word from Washington was clear Vanguard and the U S Navy would get first crack at an orbit The U S Army long accustomed to an uphill fight in the missile program went about its preparations with the quiet efficiency and dispatch that was typical of all its activities at Cape Canaveral When the delicate and capricious Vanguard faltered there was a sudden and dramatic reversal in Washington the Army got the green light to move its unique and amazing rocket to the pad and to prepare to launch

The main stage was the reliable Redstone rocket—known as Jupiter C—especially modified with longer propellant tanks But whereas the Vanguard satellite was round and designed to remain fixed on its axis in space the Army satellite was cylindrical in shape and was de

signed so that it would stabilize itself in flight by spinning at high speed like a bullet To provide the spin and the final orbital thrust, three high speed stages had been designed to fit on top of the guidance compartment located above the main stage The first high-speed stage was a bucketlike device containing a ring of eleven small solid-propellant rockets The bucket was designed to spin before the rocket left the ground and the bucket in turn rotated everything above it Nested inside the top of the bucket was the third stage cluster of three more rockets, and atop this was the single rocket of the final stage with the 30 8 pound satellite attached The spinning added another advantage if any of the small rockets failed to ignite or burned unevenly the spinning motion would so distribute the thrust that the payload would not be unbalanced The three high-speed stages were designed to fire at six second intervals and, after fourth stage burn out the empty fourth stage casing remained attached to the satellite It was, in effect, a sixteen-rocket space vehicle of seemingly great complexity, but compared with the sophisticated Vanguard for instance it was ingeniously simple — if it worked

The Jet Propulsion Laboratory in Pasadena was responsible for the high speed stages Dr James Van Allen of the University of Iowa designed the instrument package for the satellite Responsible for the powerful main stage and overall administration and planning was one of the most interesting collections of missile brains in rocketry Core of the Army team at Redstone Arsenal in Huntsville Alabama was a closely knit group of about a

hundred Germans who had served together under Dr Wernher von Braun at Germany s great missile base at Peenemunde At von Braun s request the Germans were brought to Fort Bliss Texas in December 1945 under Operation Paperclip Later they moved to the Army Ballistic Missile Agency in Huntsville to work as a team

The United States at large knew little about this mysterious group of Germans Even at Cape Canaveral they tended to stay to themselves and were seldom seen at public gatherings But they had the undeniable respect of professional missilemen and enjoyed a reputation for hard work and thoroughness In charge at Cape Canaveral was a former German who had fired more rockets than any other man on earth soft spoken genial saber scarred Dr Kurt Debus who typically dressed like a college professor wore conservative suits and crepe soled shoes or tennis shoes He could always be identified around the launch pad by his glistening black hard hat an item of clothing incidentally which is to missilers what the leather jacket was to the early days of aviation

On the last Vanguard the betting odds among newsmen had been seven to one against but because of the great respect of the press for the German team most newsmen argued privately that the Army had about an even chance Members of the Army team I talked with were quietly confident Said one JPL representative 'If we get fire under the bird we ll orbit

On the night of January 31 1958 three buses of reporters and photographers loaded up outside General Yates s headquarters rode past the rows of motels with

their blinking animated rocket signs and were checked in through the security gate at the south end of the Cape That night the Cape s lights and futuristic collection of weirdly shaped antennae seemed strangely in suspense Overhead a real satellite, a three-quarter moon, floated in and out of racing cumulus clouds Then we saw the great white Army rocket pinpointed by a phalanx of powerful bluish-white searchlights Could it really be possible that the Army on the very first try would accomplish what Vanguard had failed to do? Or would the Army bird like TV-3 end in a tragic explosion on the pad? When we arrived at the press tower, the count was already T minus 95 minutes In an hour and a half we'd find the answer We were not the only ones in suspense At the Army telecommunications room in the Pentagon, Dr Wernher von Braun Secretary of the Army Wilbur Brucker and hundreds of officers scientists and newsmen watched the progress of the countdown on a huge screen In Augusta Georgia President Eisenhower stood by near his telephone

At 9 42 one of the launch team pressed the button for the warning horn As it blasted eerily from the launch area — two shorts and a long two shorts and a long, two shorts and a long — it sounded like an awesome herald of outer space Two red warning lights began blinking steadily The 65 000 pound thrust rocket looked like a huge stalagmite fuming and smoking in its ring of lights At 10 38 the bucket and upper stages began to spin slowly accelerated to about five hundred revolutions per minute

Tension was mounting in the blockhouse Youthful Bob Moser the man who 'talked the countdown check points into a telephone linkup of key blockhouse personnel inquired calmly Control panel O K ' The answering ' Roger came back swiftly

Ground recorder

Roger

' Pad safety

Roger

Pre cooling on minus four minutes

Three and a half stand by for power transfer

Call out if anything is wrong

OPBR off — on I mean

Hold it

What happened

It s O K

Power transfer off '

T minus one minute forty seconds

Now the final seconds approached The words on the countdown sounded swift and clipped as if every phrase were a sort of hurried prayer that nothing would go wrong Everything else was deathly still The rapidly spoken song of the count rolled off the irrevocable approach of American space history

Bob hold twenty one Either relay kicking out or something dropping out on jet vane

' Number twenty one?'

'That s a missing pulse

Shall we go ahead Jim?

Sure — it won't hurt us We re O K

"Counting '

' Good Lord, I m missing a page

Counter Bob Moser in the excitement had accidentally turned over two pages at once in his seventy seven page countdown book He quickly discovered his error and continued The count was now T minus 10 seconds

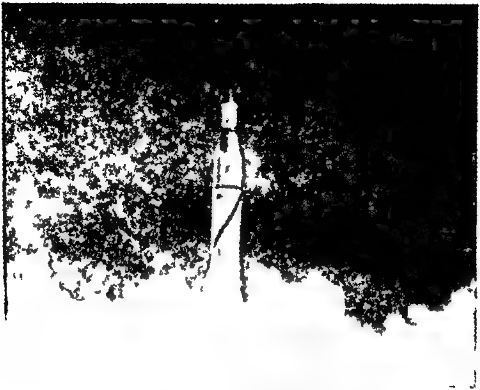
' Firing command'

Ignition '

Those of us watching the rocket saw the burst of flame at the rocket's base blossom into a cloud of smoke and sand The rocket moved instantly, supported by its rising chandelier of white-hot flame The thundering roar which surged across the palmetto flats drowned out the squawk box Thirty five seconds later the rocket passed through a small cloud burned brightly behind it, turned the cloud an incredible blue Then the light bloomed in a clear patch of sky plunged into a bigger cloud Slowly — as if smothered in moisture — the light f[illegible]d like a dying match in the folds of the cloud When the light reappeared above the clouds it was weaker, faster, redder trailing a faint wake of vapor across the night sky

Exactly 195 seconds after launch the tiny red light was suddenly extinguished The roar faded gradually like the sound of a train burrowing through a tunnel After such a majestic launch it was impossible to believe an orbit hadn t been achieved

One reporter dropped his only pencil and did not bother to pick it up Another was so excited he forgot to make a single notation Sweat stood in drops on the fore



Jupiter C blasts off carrying Explorer I,
the first U.S. satellite to go into orbit

head of CBS newscaster Chuck Von Fremd. "That's the greatest thrill I've ever had in reporting," he said breathlessly. "It even topped Ted Williams's ninth-inning homer in the 1941 All-Star game in Detroit. I felt patriotic all of a sudden, watching that lovely little son of a gun go up there!"

Even while he was talking, a final essential operation was taking place. The massive first stage had dropped off

and was tumbling slowly down into the sea Waiting before a bank of instruments at Cape Canaveral was a former German rocket expert, Dr Ernst Stuhlinger He was watching four separate tracking devices At the precise moment the upper stages reached two hundred miles altitude and were on a course parallel to the earth's surface he positioned a microswitch which in effect, sent a signal to the solid-propellant rockets which ignited them Each of the high speed stages now fired automatically in turn giving a tremendous eighteen second spurt to the satellite itself If the instruments told true, Explorer I should be in orbit

In the silence following the launch I became aware for the first time that I had heard a strong whine over the loudspeaker which steadily increased in pitch as the rocket gathered speed and power This was DOVAP an audible signal sent from the satellite which, after interpretation, gives the satellite's exact speed at any given second The faster it goes, the higher the whistle By ana lyzing the different sounds arriving at say, three ground stations twenty miles apart the exact position and flight path can be determined

By using this method in combination with worldwide tracking devices, the Army team knew by the time we met with them three hours later that the first American satellite was securely in orbit As Army General John Medaris and his group of JPL and Huntsville colleagues filed across the front of the base theater, I looked especially at the faces of the Germans searching for some sign of elation I found none They appeared pale tired

and extremely calm in the glow of camera lights It was one of their first appearances in the spotlight and they were too disciplined or possibly too excited to show any emotion over their magnificent achievement They reminded me of people who had worked long in secret inside a cave — now brought up for the world to see They were accustomed to the intricate details of rocketry, not the press or public

After the conference I returned to my motel to write my story until dawn To get General Medaris s personal reaction I asked the reporter working with me, David Ladd to follow Medaris eighteen miles to his own motel room Ladd said later Medaris thought he was being fol lowed by the police and was grateful to invite a *Time* correspondent inside his quarters

Ladd reported that the general and his friends were too excited to think of sleep From time to time Medaris s eyes lighted up and he said Think of it it s solidly up there I still can t believe it Medaris said the expected life of Explorer I was two and a half to ten years It was a night to remember for the U S Army particularly for Werner von Braun s Huntsville team which in a single dramatic launch had more than justified its long fight for the right to space

Explorer I circled the earth once every 114 minutes at a higher altitude than either of the Russian satellites Al though much smaller than the Sputniks it was equipped with excellent instrumentation designed to measure three things cosmic rays the rate of impact of tiny particles of micrometeorites and the internal temperature of the sat

ellite itself taken at four places inside its shell Data on each of the three subjects had to be collected and studied before we could hope to send a man safely into space Within minutes after an orbit was achieved we began receiving technical information on the upper atmosphere never before obtainable We were making deposits in the great bank of space travel

Within a few weeks the Army tried to launch Explorer II to obtain additional information, but there was an error in course that caused the satellite to plunge back into the earth s atmosphere and consume itself in the intense flame generated by high-speed atmospheric friction But on March 26, Explorer III achieved a partially successful orbit that lasted nine weeks

Explorers I and III sent back an amazing and in some ways frightening discovery The tiny instruments designed to measure the amount of deadly radiation above the earth s atmosphere were completely swamped There was so much radiation to record that the instruments blanked out, the amount was far greater than anyone had supposed To some it might indicate that no man could survive a hazardous passage through the belt of deadly radiation Consequently, American scientists decided that all the instruments of Explorer IV should be devoted to a detailed accurate measurement of what is known as corpuscular radiation We were preparing mice, monkeys and human beings for space travel but until we knew whether or not they would survive we might be wasting our efforts

Early in the morning of July 26 we once again en-

tered the fascinating sanctum of Cape Canaveral On the Army pad was a new rocket already positioned for a new course that would take it in a northeast direction just east of Cape Hatteras North Carolina, west of Bermuda, east of Newfoundland, and thence over Central Europe Turkey, Russia India, Australia the Pacific Ocean and California The satellite itself was the heaviest we had thus far attempted to launch 38 43 pounds Since the planned course was so far northeast, the rocket would lose some of the thrust advantage previously given it by the rotation of the earth Consequently, its thrust was beefed up with a new and secret fuel

The satellite instruments consisted of two Geiger-Mueller counters and two scintillation counters designed to determine once and for all whether the earth s radiation band constituted a permanent barrier to space travel or whether it was minor enough for simple protective steps to insure safe passage through it Results of this one launch could determine the entire timetable of space travel

Von Braun Admiral John Clark and two Army generals were in the blockhouse Range safety personnel had their fingers crossed because the planned trajectory brought the rocket close to the U S mainland

At 9 59 in the morning Explorer IV climbed up from the Cape arched over the bright sun and headed out on an unfamiliar course that appeared to take it directly up the U S coast The first station that confirmed successful orbit was Monmouth New Jersey then the rocket

whirled around the world and was further confirmed by a tracking station at Temple City, California

Later, von Braun told us the instruments had been made in eight weeks, a remarkably short time Expected life of the orbit was four years Explorer IV s lowest point of orbit (perigee) was 163 miles above the earth, its highest point (apogee) was 1372 miles

Said von Braun at the press conference following the launch 'We can t go ahead with the design of other space capsules until we know what this radiation involves"

Fortunately, within two days of the launch of Explorer IV, Dr James Van Allen announced that data obtained was satisfactory The satellite's instruments confirmed the presence of deadly radiation at about two hundred miles altitude, but the quantity was such that, with proper lead protection, a man could survive the brief passage through the deadly belt on the way to outer space

The bank of man's knowledge had received another huge deposit, and slowly but surely the way was opening for the great adventure, the flight of the astronauts

5

We Reach for the Moon

By heaven methinks it were an easy leap
To pluck bright honor from the pale faced moon
— WILLIAM SHAKESPEARE

FOR YEARS those of us who worked at Cape Canaveral — like people everywhere in America — had read and marveled about the possibility of sending rockets to the moon The rockets themselves and the day of such a feat seemed always far in the future It was comfortable to think and dream of the accomplishment without concerning ourselves with the hard specifics of thrust midair starts course adjustments payload weights and other pressing problems of practical missilery

The age of rockets came upon us so fast that even those of us close to the subject were unprepared for the astounding implications of actually shooting for the moon We had known of course for a long time that such an event was pending and I recall on many occasions looking at the bright face of the moon with a growing sense of awe and wonder that it might soon be within the reach of man Yet at three o clock in the afternoon on Friday August 15 1958 when I sat down with other

newsmen around General Yates's conference table to discuss the coming shoot for the moon, I couldn't quite believe it was really about to happen

The mysterious moon is over 200 000 miles from earth, it travels at 2200 miles per hour In places it is so hot (215 degrees Fahrenheit above zero) it could boil water, yet its shadowed side is so cold (240 degrees below zero) it could freeze all unprotected life To hit it, or even come close to it meant we should have to shoot from the spinning ball of the earth far in advance of the moon's position In fact, at the time of launch at Cape Canaveral the moon wouldn't even be visible from the launch pad Someone had compared the aiming problem to the attempt to hit a man racing on a horse with a bullet fired from a rifle aimed from a whirling merry go-round It was a bold and fantastic endeavor, even for the twentieth century, and as General Yates and scientists briefed us on the technical specifics at first I jotted down the facts automatically without really comprehending that potentially one of the most historic shoots of all time was just two days away But as the briefing elaborated on the concrete ways and means and on the equipment at our disposal it gradually dawned on me that this was neither a movie nor science fiction This was to be an actual, carefully calculated attempt to send an instrumented payload to the vicinity of the moon

In all there would be five lunar probes as part of United States participation in the International Geophysical Year The first three attempts would be made by the Air Force then the Army would have two chances The

launches would be about a month apart, at the end of each twenty eight day period when the moon passed closest to the earth — roughly 220 000 miles away The first attempt would be at 7 14 Sunday morning

The Air Force main stage was a Douglas Thor The second stage was the second stage of Vanguard And the third stage was a specially prepared solid propellant bottle similar to Vanguard s third stage In addition there were eight other rockets to rotate the second stage and provide spin stability to the probe itself The space vehicle also contained several pairs of small vernier rockets designed to make small corrections to the speed just after third stage burnout After all three stages had fired the speed would be approximately twenty five thousand mph At this speed the top shaped probe would then coast upward for two days, fourteen hours and twenty four minutes The final course correction device was the most ingenious of all in the nose of the eighty five pound probe itself was a retro rocket which would fire straight forward in the final phase of the journey to the moon

If all went well this rocket could be fired at the last minute, either automatically or by radio signal from a tracking station in Hawaii Since the probe would be floating sideways on its course ahead of the advancing moon the firing of the retro rocket would adjust its speed and in effect alter its course so that it would have a better chance of being drawn in by the moon s gravity thus enabling it to swing around behind the moon An other way of thinking of it is to consider the retro rocket a sort of brake that would prevent the probe from sail

ing on past the front of the moon at too high a rate of speed to be pulled into a lunar orbit If everything worked precisely as calculated the probe would swing once around the far side of the moon and then head back for earth completing a gigantic figure eight pattern

Inside the payload — called Pioneer — were recording instruments a micrometeorite impact counter similar to that contained in our satellites, a magnetometer designed to study the magnetic fields of both the earth and the moon and a modified television instrument designed to reproduce an electronic image of the far side of the moon

When some of us exclaimed over the seemingly great complexity and difficulty of this experiment, General Yates agreed "This is a pretty complex shotgun' he said 'and we ll be lucky to succeed on the first time out But bear in mind that even if we fail to orbit the moon every mile we go out there in space will give us some thing we didn t know before

Next day, I called on the technical director of the entire project Dr Louis Dunn of the Space Technology Laboratories As we talked in his small ocean front motel room he expressed the same caution 'We face many problems and there are many chances for error but if we didn t reach for the moon when we felt we could we wouldn t be human Right now at the Cape things are going so well with rocket preparations that it scares me Usually at this stage some small correctable thing has gone wrong to keep us busy'

Dr Dunn pointed out the difficulty the scientists had

had in planning the rocket's course over the earth 'At one point we even had one of the stages coming in over Russia but we changed the course so it will now hit the atmosphere over the Indian Ocean

As Dr Dunn discussed technical aspects of the planned flight I noticed that the ocean crept closer to us up the sloping beach As far away as the target moon was it could still cause the tide to rise on earth

The next morning as I rode toward the Cape before dawn I could already spot a few camera tripods on roofs of motels and small concentrations of cars at roads leading to the beach Twenty-seven cars were already parked just outside the Cape gate The public wanted to be in on a moment of history One enterprising politician expecting the large crowds which gathered later even parked a truck mounted sign beside the main road ELECT BILL HURLWOOD FOR A BETTER BREVARD

As we reached the press camp inside the Cape the bright morning star gradually faded as the sun rose out of the ocean into a cloudless sky The rocket looming on pad 17-A looked like a long rifle shell with a blunt rounded tip At 6 59 the speaker squawked T minus nineteen and counting' Our hopes were high and our fingers were crossed

Precisely on schedule the rocket spurted flame and began to rise At T plus 65 it spun out a white contrail Everything appeared normal Suddenly the contrail erupted into a spinning starfish of bluish smoke A streak of smoke continued upwards, but we knew the end had come After seventy seven seconds of flight our first

moon rocket had exploded As we walked sadly toward our buses, I noticed a girl reporter crying quietly

An undiscouraged Air Force colonel told me later, "The Air Force, like Ted Williams, gets three strikes Right now it s strike one We've got two more strikes coming up "

After the failure of the first Air Force lunar probe "that orbed maiden with white fire laden whom mortals call the moon' traveled twice around the earth showing us through its slight oscillations (called librations) 59 per cent of its surface Its remaining and hidden 41 per cent no man had ever seen or photographed The next Pioneer — Pioneer I the first Pioneer to be numbered — would also attempt to photograph the far side of the moon

While the moon leisurely circled as it had done for centuries, Cape Canaveral got its second great astro vehicle ready for flight In late September the first stage was trucked to the pad and mounted on what is known as the MOS (missile on stand) date or more commonly the mouse date' Despite the first failure morale was excellent among the fifty to sixty key men who comprised the Douglas-Air Force team

Leader of the Air Force group was a blue eyed bushy-haired World War II bomber veteran Colonel H H Eichel, head of the Ballistic Missile Division at the Cape Colonel Ike had handpicked his men and he was obviously very proud of them 'Missile testing is a group effort ' he told me one day in his office 'yet the entire BMD team here is made up of rugged individuals No

one man can possibly know it all or even do it all But we wanted individuals We deliberately selected rugged men with strong feelings Why I ve got one first lieutenant who has more gall than a major general When you put a group like this all together you get some action '

Colonel Ike s counterpart in charge of Douglas personnel was a genial fast thinking veteran of twelve years in missile work thirty nine year old Bill Duval whose job at the moment was to make minor changes in the bird to make it more reliable "There is no such thing as an insignificant change in the missile business ' he told me one night in his home What you can accomplish with a *very minor change is tremendous Bill Duval was also* proud of his men "The true test of members of a team is when they get into trouble together My boys have been in and out of trouble performing magnificently I think they're the best launch team in the world

During the intricate preparations of the pad two key team members virtually lived with their rocket checking and double checking every tiny operation making notes flipping through check off lists scrutinizing every nut and bolt and electrical connection They were Captain Brandy Griffith and Major Hal Meyers assistant chief of test operations For both of these dedicated missileers each rocket had a personality of its own and the current one — a bird called number 128 — was already developing little quirks and mannerisms that stamped it as mildly stubborn and capricious They got to know 128 well

While the great first stage was lying like a white prone

bowling pin in the Douglas missile assembly hangar each piece of its equipment was removed and tested Then equipment was replaced and tested again in a covers off test during which all of the numerous access doors were left open to facilitate adjustment Then 128 underwent a ' covers on" test and a meticulous weight and balance check to determine its exact center of gravity (different for each bird) After an "electrical accept ance" check in the hangar the rocket was mounted and all BMD and STL supervising personnel went through an additional checking procedure known as ' buying the bird ' After minor adjustments, they bought it

Now the second stage was carefully erected and hoisted by the gantry to its position atop the rugged Thor At the top of the second stage, conduits and link age lines protruded like nerves and tendons ready to join the next link to space Nearby on the windswept top deck of the service tower the inert missile umbilicals (propellant and electrical linkage to the ground) were trussed to a steel girder of the gantry, their moisture-sensitive ends encased in a plastic sack which, ironically, lay alongside a misguided family of wasps building a nest Luckily the wasps had not decided to build their nest inside 128 While technicians checked the conduits, I watched Brandy Griffith as he leaned against the top of the tower and listened in on his headset as each station checked in on the worldwide communications net ' I just heard Singapore, England and Hawaii he said, calmly The thought struck me that an astro vehicle such as the

one we were standing beside might someday relegate such earthbound connections to the status of a suburban interchange

In the afternoon a coterie of Pan American guards suddenly appeared around the missile base and the loaded third stage rode into the pad area on a yellow trailer The bottle was crated and covered like a corpse with green canvas tarp Now seven hard hatted workers removed the canvas gingerly stood the crate on end carefully stripped off the wooden crating affixed a chain hoist to the left ring and attached a seventy five foot steadying rope to the white bomb shaped metal bottle packed with the most efficient solid propellant U S labs could develop This was no jackleg crew but a quiet cautious team of specialists who worked with the efficiency and grace of master mechanics As the cables hoisted the third stage skyward one man steadied it with the attached rope Slowly the dangerous third stage climbed the huge 110 foot red and white service tower

Later after third stage mating was completed as an ambulance and two fire trucks stood by the launch pedestal a platform containing a white tank filled with fuming white nitric acid was hoisted to the eighth deck opposite propellant intakes on the second stage When *fueling began the entire eighth deck smelled like a chem*istry lab Now a similar platform containing a white tank of UDMH was chain hoisted to the eighth deck As the protective plastic environmental shelter flapped and surged in the breeze four rocket technicians dressed in hot gray and yellow rubber acid suits hooked up lines

to the rocket and opened UDMH valves While they continued the dangerous fueling in their weird looking hoods and rubber boots, five STL men in green surgeons' gowns finished minute adjustments to the payload on deck nine To reach deck nine they had to clip brass static arresters to the instep of each shoe (to avoid accumulating body electricity which might set off a spark) They also had to sign in with a Pan American policeman stationed on the stairway below the ninth deck As they worked the counter broadcasted, T minus six hundred and counting

Several hours later fueling was completed and rocket test technician Ed Bauer zippered up the environmental shelter, picked up a small sample bottle of UDMH, rode the self operated elevator down to turn over the bottle for analysis as one of countless similar procedures put on the record to assist determination of failure if an accident should occur The great tower stood deserted and waiting The rocket inside it glowed greenish white in its halo of light

Now everything except the first stage was loaded The only thing which remained to be done until the countdown resumed some six hours later was to check temperature of propellants from time to time and keep a careful watch for leaks Leaks were of vital importance because if the acid and UDMH came into contact with one another they would explode instantly

During the waiting period the launch pad crew got up a pool at a dollar a chance on the exact time of lift off Also during the waiting period a spare payload was care-

fully checked out in the 'payload lab in the missile as sembly area If needed on the rocket, the spare payload would be decontaminated in the same way the original payload had been, to avoid the possibility of placing earth germs and bacteria on the moon if the probe should actually impact To decontaminate the original payload parts had been removed bathed and rotated under a canopied ultraviolet light for about fifteen min utes Some of the parts and all installation tools had been washed in a medical disinfectant called chlorophenyl Then the whole thing had been reassembled, wrapped in sterile white sheets and packed in a white wooden box for shipment to the pad The spare was ready to undergo the same procedure if anything in the payload were wrong

While the dramatic moon launch was approaching just seven hundred yards away on pad 56 another count-down was progressing with the Army's Jupiter rocket which would soon have its own chance at the far fron tiers of space As this count approached zero on Thurs day night Bill Duval and six of his engineers were dis cussing progress of the lunar probe in a beach house known as the Douglas House in Cocoa Beach seven miles south of the pad Suddenly there was a tremendous roar above the Cape The first thought of Duval and his engineers was that 128 had exploded They raced for the screen door The latch stuck For nearly a minute they frantically fumbled with the latch then ripped the door off and ran out into the open Over the Cape they saw a huge rocket falling back to earth A moment later there

was a reverberating explosion as the rocket blasted out a huge crater of Cape earth Duval raced back in to his phone didn t relax until two minutes later he learned the explosion was that of the Jupiter rocket which had occurred near but not on top of the nearby moon rocket Nevertheless, shock waves had tumbled through the latticework rocked 1.8 on its tracks and shaken up the crew in the blockhouse Duval ordered still another complete check of the astro vehicle from top to bottom Fortunately nothing was found to be amiss, but it was an ill omen and shook the nerves if not the confidence, of the launch crew

At 4 A M Friday, October 10 1958, the fifty members of the lunar probe launch crew, wearing an assortment of sport shirts coveralls and business suits, took their seats in blockhouse 17 They were predominantly young men Test conductor Earl Wollam was twenty-nine and test conductor Ted Gordon was twenty-eight Harold "Alligator Eaton, the man who would push the button at T minus zero — starting up the automatic firing sequencer — was twenty-seven Each man wore, in addition to his security badge, a pink blockhouse admittance badge labeled BH-17A As the count progressed Wollam and Gordon conducted in relays By afternoon minor difficulties caused a series of holds The holds were all something we could take care of " said Wollam 'I liked it better than last time when things went just too well for comfort '

As night approached, an air of calm and confidence built up in the blockhouse Somehow it was communi-

cated to the press observation tower just over a mile away where I waited with ninety eight other newsmen and photographers Writer Martin Caidin offered to bet a hundred dollars that the rocket would escape the earth s gravity he got no takers

By 1 50 in the morning when the lighted gantry moved back on its tracks a thin veil of fog hugged the Cape palmetto flats Then the searchlights were turned off and the astro vehicle loomed like a gray ghost above the undulating mist

We didn t know it at the time but a serious structural problem had developed on the pad Ted Gordon came up to Bill Duval told him that they could not seat four screws out of the required seventeen in an aft access plate Duval went out to the rocket and noted with dis may that four of the screw holes did not line up prop erly But he knew the cover plate was a nonstress cover that is there was no pressure behind it

Bring me ten inches of pressure sensitive tape said Duval While the launch crew held its breath, Duval had the access cover securely taped down so that air couldn t get in behind it to loosen it Then the small group of men went back to the blockhouse

At 2 55 A M a quiver of searchlights froze the eighty eight foot rocket in a brace of icy blue light The fog swirled mysteriously around the rocket s base

There was the flame! Seconds later as the fifty ton rocket rose the fog turned to brilliant gold like a scene in a dream

Go baby said a voice

"Go, bird please go —" said another

"Go, go, go! Please Lord let it go!

It went Straight up Arching over Roaring

The flame burned steady and true We saw the first stage burn out precisely on schedule We saw other stages fire for forty-two more seconds

For sixteen minutes newsmen rasped their stories into sixteen long distance telephones high on a tower on a foggy night Then popular information services secretary Jo Downey listening in on a phone to Central Control shouted Yes! It s yes! The third stage fired It s on the way!"

Newsmen shouted The longest I ever held my breath, said one

At 5 A M a new crescent moon rose above a cloud bank over the ocean It seemed like no other moon ever beheld It was now a legitimate target of earth

The next day Pioneer I was still climbing Eight hours after launch it was fifty two thousand miles out, every second it traveled it broke all known altitude records for instruments in space For once, we had done something ahead of the Russians Triumphant headlines echoed around the world Congratulations poured in from all over the globe

But, unfortunately as worldwide tracking information filtered into the Air Force Space Reporting Center in Inglewood, California, it became obvious Pioneer I would not reach the vicinity of the moon By 7 09 P M its speed had dropped to three thousand mph A tiny increment of velocity and a very slight course error had

been just enough to eliminate the last part of its mission Nevertheless the launch was a trail blazing success When Pioneer I finally lost its energy and arched back toward the earth it was one third of the distance to the moon — seventy two thousand nautical miles out in space Its altitude was more than twenty seven times greater than ever before achieved and it had sent back the first measurement of radiation above twenty five hundred miles In addition it had served as a radio repeater station between two points on opposite sides of the earth

The next Air Force attempt to reach the moon one month later is one of the saddest chapters in modern rocketry When rocket number 129 went to the pad feeling was high that the third time was charmed For two days preceding launch I climbed all over the tower talked to most of the people who would fire her This one s gonna go all the way was typical of the many confident comments I heard Near the top of the rocket I wrote on its white skin ' *Time* and *Life* were here Go Go Go — and scribbled my name I also gave a portion of a poem by Tennyson to the pad foreman and learned later he had stenciled the following words in huge letters near the rocket s base After it follow it follow the gleam! On the top of the rocket missilemen had written their names and the names of their children

After a promising blast off on November 8 the third stage unaccountably failed to fire The Air Force after a brilliant second swing deep into space had struck out on the last pitch Now it was the Army s turn at bat

Twice more in 1959 the Air Force scheduled shots to the vicinity of the moon this time with the largest rocket to date in the U S missile program a big booster called the Atlas-Able for which a special launch tower the tallest at the Cape, had to be constructed The first attempt, on September 24 ended in one of the largest pad explosions ever seen at Cape Canaveral Damage to the launch complex was extensive The failure was particularly untimely because just a few days later Russia launched Luna III which succeeded in taking the first photographs of the far side of the moon

By November 1959 the Russians were busy mapping the unseen face of the moon, applying, as was well within their right, Russian names to the "seas," craters and peaks of the lunar landscape while the United States was finally cranking up its second huge Atlas-Able This one, called the Double-A was not only designed to photograph the moon s far side, it would also attempt to remain in orbit around the moon Newsmen had their fingers crossed It was a good time for a great success President Eisenhower was about ready to take off on a tour of three continents Besides, the shot was scheduled for Thanksgiving morning

For the first half-minute the ascent looked good, then at T plus 40 seconds I was startled to see a small fiery object fall off the side of the rocket and tumble toward earth, never before had I seen anything like this It was much too early to be the main Atlas booster I couldn't prove it but I sensed something had gone wrong Next day we learned the sad news that the protective plastic

nose fairing had jarred loose and the resulting severe atmospheric friction had damaged the rocket's upper stages probably dislodged the payload itself The earliest the United States could get a payload to the moon would now have to be sometime in 1960

6

Army Orbits the Sun

ONCE AGAIN the Army moved in as a pinch hitter after the first three Air Force failures to escape permanently from the earth s gravity This time it had a new rocket combination called Juno, consisting of a Jupiter IRBM plus three stages of solid propellant high speed rockets The objective differed from the Air Force's chiefly in that the Army did not plan to circle the moon but merely, in effect, to recognize it as the probe sped by on a much more ambitious trip through our solar system If all went well, Pioneer III would orbit the sun itself

This was one of the first rocket launches scheduled to be fired under the auspices of the newly formed National Aeronautics and Space Administration the civilian fed eral space agency The first representatives of the high budget NASA to show up at the Cape were unfortu nately, poorly prepared individuals who exuded an aura of self importance They gave the initial impression that — now that they had arrived on the scene — everybody could just move his toys to one side and give them operating room the space age, their manner suggested had

now begun Although NASA later acquired many competent individuals the early impression was unfavorable The new federal agency made itself unpopular with perceptive elements of the nation s press — and this relationship unfortunately was to become a great handicap to its mission in the years to follow

The same reliable and familiar launch team was on hand Dr von Braun General Medaris Dr Kurt Debus and Jack Froehlich of the Jet Propulsion Laboratory, plus their experienced crew of experts

Preparation at the Cape began two days after the third Air Force attempt failed, when a shrouded Jupiter with special elongated fuel tanks arrived from Huntsville, Alabama in a C-124 aircraft Late in November Juno was moved from hanger D to the Army pad The spin mechanism and upper three stages were carefully checked out in the JPL Quonset hut behind hanger R

A few days prior to scheduled launch on December 6 the entire bird was assembled in the 110 foot gantry and the new protective fairing was placed over the upper spinning stages The purpose of the fairing or air shield was to prevent aerodynamic heating, it would be jettisoned shortly after burnout When the bird received its complete simulated flight test it checked out excellently

Friday morning was used chiefly for rest and sleep before the long strenuous countdown began Most of the 350 people of the Army Ballistic Missile Agency did not report for work until afternoon, when groups checked in in staggered shifts

For relaxation General Medaris played golf at the nearby Melbourne Country Club Von Braun met that afternoon with his chiefs to decide on the final, exact programming of Juno based on latest weather estimates and direction of high-altitude winds

That night the countdown progressed steadily until T minus zero just after midnight — within twelve seconds of the exact time set more than three weeks earlier The rocket with its gold plated Pioneer III payload gave me a fright as it continued to sit on the pad after cascading rainbow hued billows of its own ignition engulfed it But it was only the increased weight which required longer thrust buildup for lift off that made it appear to be consumed in its own flames After six long seconds it rose from its own inferno and climbed majestically in the cloudless, calm Florida night Said reporter Ross Mark of the *London Daily Express*, ' You Americans have done it again " But his verdict was premature First hint of trouble was the long delay before an uncertain NASA representative confirmed that all four stages had fired As buses headed back for the base, I suspected an incomplete success

We learned later to our dismay that the first stage burned out 3 7 seconds early causing a vital speed loss of four hundred miles per hour

Nevertheless, Pioneer III was considered a qualified success Its thirteen pound instrument package didn't orbit the sun but it did reach an altitude of 63,580 miles and telemetered to earth valuable radiation data

Now the Army had one more chance in the special IGY series The Juno II rocket, called missile number AM-14 got off to a bad start The first attempted launch on February 28 was postponed because of overcast skies (Range safety requires a minimum two thousand foot ceiling) The following night, fifteen minutes from launch a battery powered transmitter in the payload failed and the flight was scrubbed

On the clear, gusty Monday night of March 3 1959 the sixty ton rocket again stood tall and erect on its pad In the blockhouse were test conductors Bob Moser Gen eral Barclay Froehlich and von Braun The best dressed man in the blockhouse was soft spoken scholarly Dr Kurt Debus in a dark blue suit and carrying his badge as director of the Army Missile Firing Laboratory He also carried a cardboard accordion firing jacket containing the seventy two page countdown safety rules and every previous decision he had made on the Jupiter rocket

Blockhouse personnel said the scene leading up to the firing was the least tense of any launch Smoking con tinued even after the steel blockhouse doors were bolted shut One man calmly lighted a cigar at T minus 2 min utes

Said Gordon Harris of ABMA later At launch some clods of dirt were blasted against the blockhouse win dow Then just after she pulled out of view most of the fifty people crowded inside rushed over to the measuring racks where the velocity and programming are traced out in red ink on a flowing chart I heard Kurt Debus and

then Bob Moser say, 'It looks good' Then, later when for the first time there was a touch of excitement, we saw indications of the needle that high speed stages had fired and I remember von Braun said, after a moment, 'Well, we have a new planet

Thus, in a quiet unexcited voice, did Gordon Harris describe the deceptively calm atmosphere in the blockhouse at the historic moment our scientists first realized we were well on our way to an orbit of the sun

Steel doors were opened fifteen minutes after blast-off Kurt Debus in his Army staff car and von Braun in his gray 1959 rented Ford dashed over to the telemetry evaluating room in Army hangar R then checked velocity in the JPL Quonset hut just outside Ninety minutes after launch a beaming Jack Froehlich and a calmly satisfied Kurt Debus showed up at the press observation tower Both were relaxed and obviously pleased Said Debus 'Our most important delay was four seconds, due to the sluggish closing of a vent valve Blast-off came within four seconds of optimum firing time" Said Froehlich, "I feel real good I m going home to celebrate'

From outside the blockhouse, the full 187 second first-stage firing was clearly visible even though the tear-shaped flame dimmed orange as it passed through a high-altitude veil of cirrus clouds, forming a bluish ring around the exhaust After fifty five seconds of dark, coasting flight we saw the faint glow of second stage ignition According to my calculations we were then watching an event 292 miles away The weak light was

just north of east and moving closer to the horizon as the rocket was already curving around the side of the world on its way to the heart of the solar system itself — the first American instrumental package to escape fully the gravity of the earth That was the last I saw of Juno II When the glow finally faded, about three minutes after lift off I heard a man say quietly There goes history

History now was in the form of a thirteen pound probe, twenty three inches long as it continued its fantastic journey into space Its early speed in relation to the earth was 24 900 miles an hour After thirty three hours Pioneer IV crossed the path of our moon From this point on, its course was determined chiefly by the gravity of the sun itself — more than ninety two million miles away

The tiny batteries had a life of seventy five hours — long enough to report back some of the facts we wanted as Pioneer IV swung into a tremendous orbit some four hundred thousand miles from earth around our sun It acted, as von Braun said just like a planet such as Mars Venus or Earth Without the gravity of the sun the space probe would have continued across our solar system and far into the deep unknown of outer space But the powerful magnet of the sun acted in effect like a giant, comparatively slow-moving whirlpool and Pioneer IV like the other planets of our solar system was caught in the revolving current Its speed or centrifugal force kept it from dashing into the face of the sun yet the draw of the sun itself kept it from flying off into dis

tant space Pioneer IV was in a state of near perfect balance and like the earth it was a satellite of the sun

One year to the day from the humiliating disaster of the Vanguard explosion, the United States had become a nearly equal contender for the starry throne of space

7

The Titan ICBM

THROUGHOUT 1958 each time I went inside the Cape I noticed steady progress on four huge launch complexes extending the line of Atlas towers northward along the coast These blockhouses and massive service towers were for our second ICBM the Titan which was first ordered into production in 1953

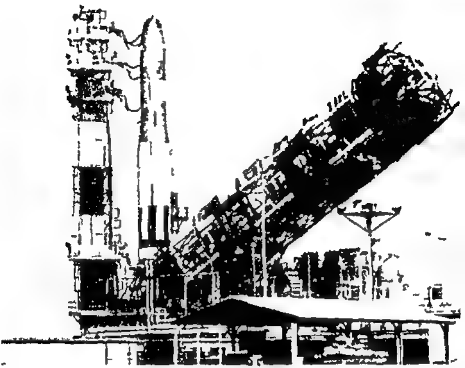
On February 6 1956 ground was broken just outside Denver, Colorado for the Martin Company's factory and test stands which would build and check out the largest rocket then under construction in the United States

The first rocket to arrive at the Cape, a bird called A-1, was strictly a ground bird designed to test the launch facilities as soon as they were complete on pad 15 Although I hadn't yet seen Titan reports from the pad gave me some idea of its size The height was over ninety feet the exact size depending on what type of nose cone was used The first stage was a huge liquid-propelled monster ten feet in diameter and fifty seven feet tall The second stage was nearly five times larger than any second

stage then in existence — eight feet in diameter thirty-four feet high A double-exhaust Aerojet General rocket engine provided power for the first stage in excess of three hundred thousand pounds thrust The second stage was powered by another Aerojet of over eighty thousand pounds thrust at altitude Both engines were powered by the simplest and most reliable propellants then in use lox and RP-1 — high grade kerosene

One Titan missileman said he had actually walked around inside the rocket 'It s like a huge, tall room in there" he said 'and your voice has a weird sound to it It s so big you feel like you ought to whisper'

Late in 1958 and early in 1959 four big Titans were flown from Denver to the Cape landing strip Their numbers were A-3, A-4, A-5 and A-6 On the day A-3 was scheduled for launch General Yates invited me to watch the shoot with him on his closed circuit TV set Because of his busy schedule the Atlantic Missile Range commander often watched launches on television in a small conference room just down the hall from his office I took my seat among a handful of Air Force officers and engineers and had my first look at Titan through the close up lens of a TV camera Unlike its competitor Atlas Titan resembled a blunt nosed artillery shell The two stages were joined at a definite point of taper The service structure, instead of rolling away on tracks as all the others did simply tilted slowly down to a horizontal position A tall umbilical tower remained erect and from it thick power and fuel lines fed into the top of the missile Lox vapors streamed out from both stages At T mi



Titan ICBM just before launching

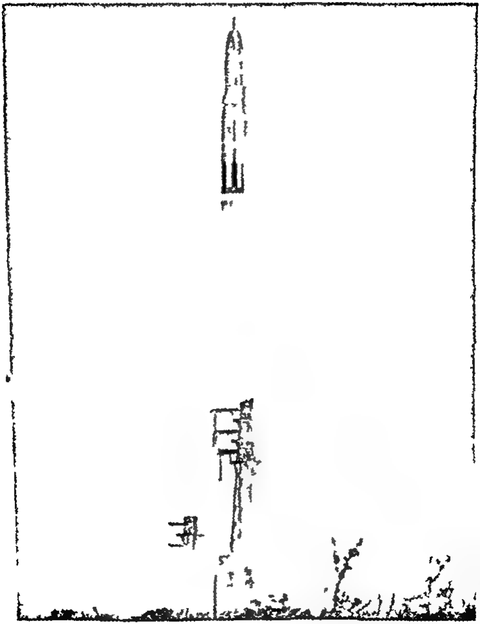
nus zero we saw the fire blossom briefly at the base then go out I learned later that a slight engine malfunction had caused the sequence timer to shut off the engines automatically This was one indication we were making progress in our ground support equipment because in the old days the rocket would have been unstoppable at this point and would probably have roared off to an expensive explosion

A-3 and later A 4 were both flown back to Denver for an engine change, nevertheless beginning in February 1959 four successful Titans, including both A-3 and A 4 were flown in just four months The flight of A 6 on May 4 successfully tested the separation of a dummy second stage

The next rocket scheduled was B-1, designed primarily to test the crucial ignition of the second stage in the air Up to this point many rockets including satellite launchers, had failed because of the inability to achieve a successful midair start Midair starts had thus become one of the biggest hurdles in liquid propelled rockets and Atlas men were quick to point out how they avoided this hurdle by so designing Atlas that its second stage in effect, could be ignited on the pad At stake in the firing of B-1 was the whole concept of midair starts If the Martin Company which had also built the trouble-plagued Vanguard could demonstrate that it had solved the critical problems of igniting upper stages at high altitude U S rocketry would receive a shot in the arm

Not many newsmen were on hand for this important test The first attempt to launch B-1 on July 31 1959 was called off chiefly because of weather delays after sixteen newsmen and photographers waited an entire rainy day

The next attempt August 14, ended in a fiery catastrophe, the entire rocket blew up in a great ball of fire which rose above the launch pad Titan s test of its important second stage was indefinitely postponed Meanwhile as Titan delays mounted through November



A Titan blasts off

1959 some informed missile fans began to suspect that our backup ICBM might be in serious trouble — with something far more fundamental than the second stage Reports reached Canaveral that several Titans had proved faulty at the test facilities near Denver one was cracked in shipment to the Cape

On December 10 a few newsmen again gathered to watch the big Martin rocket blast off but again Titan sputtered on the pad then shut down in an automatic cutoff The big heavyweight of the first generation of U S missiles — in its unpredictable test program — was under close scrutiny by Air Force brass and members of Congress Like all U S ballistic missiles, it was having early difficulties but like all of them also it eventually overcame its glitches and established major milestones in the conquest of space It was Titan which safely lifted the Gemini astronauts and it was an enlarged and improved Titan that eventually became the most powerful U S booster in existence

8

The Proving Ground

ONE OF THE MOST important early lessons that Cape Canaveral taught was that there is no real distinction between rocket research conducted for purely military purposes and rocket research conducted with nonmilitary scientific objectives. The two are bound closely together. In one respect rockets are like airplanes and ships: they represent a means of transportation. It is true that, because of the tremendous expense involved, the first and most advanced versions of most rockets have been designed as weapons of war under government financing. Private industry simply cannot afford the cost. But invariably ways quickly present themselves for utilizing the space weapon as a booster or carrier for scientific experiments, just as ways have been found for using military developed aircraft and ships for peaceful purposes.

Early research and development rockets at Cape Canaveral did not carry live warheads. They carried ballast, and ballast in the long run can stand for anything—mail, freight, communicating equipment, animals or people, as well as explosives. I think historians of the future

will take note of the fact that despite the well-advertised urgency of the world military situation, our first generation of missiles and rockets was also widely used to gather scientific information, not only about the unfolding realm of space but also about our own world and its magnetic and atmospheric blanket

Thus it was that at the same time we tested our first-generation missiles — our Matadors, Snarks, Bomarcs, Redstones, Jupiters Thors Atlases, Polarises and Titans — we also found time to add to man's knowledge of the universe, sometimes by using various combinations

One famous use of a military weapon for nonmilitary purposes was actually the best-kept secret in the history of Cape Canaveral Late Thursday afternoon, December 18, 1958, I was sixty-five miles from Cape Canaveral driving to my home in Winter Park, Florida Just as I made the last turn in to my house, I saw through the windshield a large, brilliant light rising slowly above the trees I recognized it immediately as a rocket, slammed on my brakes and jumped out to watch it

As the light rose, I reviewed the week's schedule The only thing it could be, I decided was a "routine Atlas' General Yates had said was scheduled for Thursday Yet this light did not follow a routine Atlas course downrange It programmed much higher and carried along with it a bluish tear-shaped shock wave ("aurora") many times bigger than the flame itself When the light finally died after about four minutes I got in the car and drove thoughtfully home and turned on the radio The next news report contained nothing about missiles, so I pro-

ceeded to a friend's house for dinner There, over the radio I heard an astounding piece of news The United States the report said had just succeeded in placing in orbit an entire Atlas I recalled immediately a remark Mr Mac had once made to me, almost casually "The Atlas alone is capable of orbiting a two-thousand-pound satellite

I gulped down my dinner and raced home Shortly thereafter Ed Rees the Pentagon correspondent for *Time*, phoned to say arrangements had been completed at Headquarters USAF for me to fly back to Washington with Roy Johnson, director of the Advanced Research Projects Agency under whose supervision the shot had been fired I got in the car and raced for the Cape Just before dawn I met Roy Johnson outside the operations building at Patrick Air Force Base His plane was delayed briefly and he and four of his advisers — all in overcoats — gazed up from the concrete ramp into the starry night Somewhere up there circling the globe was an entire Atlas rocket by far the biggest and heaviest object we had yet placed in orbit And these men who had planned it seemed as awed at what they had done as I was

When we first got in the plane and headed for Washington Roy Johnson went to sleep Later after he had rested he invited me forward for coffee and a chat and there high above the clouds just after dawn I learned how Project Score had come about Only eighty-eight men in the country knew it was not a routine Atlas In fact most of the men in the blockhouse thought it was

just another range test I learned it contained special recording devices designed to rebroadcast President Eisenhower's voice from outer space The rocket subsequently did just that relaying the President's peace message sent to the circling Atlas from Texas, Arizona and Georgia

The total weight in orbit was 8750 pounds Atlas raced around the earth once every 101 minutes As a correspondent I had almost missed one of the great missile stories of the year I was both proud of our country's ability to keep a major secret and grateful for the opportunity to talk with those who made it possible As I landed in Washington and raced to a typewriter to file my story I knew another milestone had been reached This was the first time any human voice had been received from space The experiment represented an important forerunner of the day — not too far in the future — when we would communicate with other continents by using satellites as audio and video relay stations

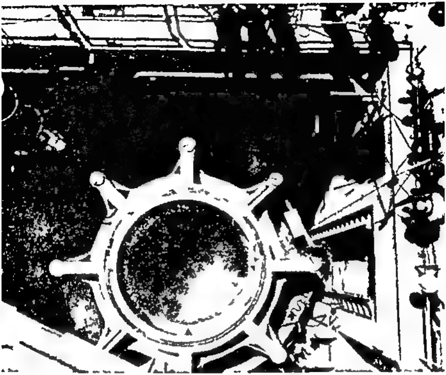
During the first four years of actual rocket improvement, facilities at Cape Canaveral also helped to refine our knowledge of tracking procedures, especially the use of AZUSA and DOVAP The United States learned more about communications, especially the construction of miniature equipment which would still work after a rugged journey through the atmosphere and we learned how to send coded data to earth through the use of telemetry, or missile back talk We improved our space age photography through development of such giant cameras as ROTI, which could photograph a package of

cigarettes at a distance of eight miles and could tell missilemen exactly how an upper stage separated from a lower one high in the heavens The missiles needed many types of highly specialized ground equipment we learned how to design this equipment and how to make it reliable Making transporting and storing their fuel was a delicate and hazardous undertaking Some rocket fuels were so unstable that the decomposition of a single speck of dust could generate enough heat to explode a fuel drum One man at the Cape a drum patter had the job of feeling rows of fuel drums with his hand for signs of heat We also learned at the Cape s bustling lox plant how to handle liquid oxygen which is so cold that once when I placed a rubber hose in a bucket of bubbling lox then struck the hose against the concrete it shattered into pieces as if made of clay

One of the most important things we were learning about rocket fuels was how to make and use effective solid propellants As early as 1956 I had occasionally seen small swift and usually red painted solid rockets streak up from the Lockheed test facility on the Cape Most of these early launches unlike liquid propelled rockets left a dense trail of grayish or white smoke There were two big problems to get the hard gunpowderlike fuel to burn steadily and evenly and to get it to cut off at the exact point desired Over a period of time early small solid rockets gradually gave way to larger test configurations of the Polaris rocket being developed by the Navy to be fired from ships and eventually from submarines Advance publicity about the Polaris was

even more enthusiastic than the publicity surrounding the Navy's Vanguard program If we had believed the early claims we would have assumed that the solid propelled Polaris was the answer to all rocket problems Reports claimed it could be stored easily and fired quickly that its basic combustion was so simple that it would have more reliability than liquid rockets, and that when fired from submerged subs near an enemy coast its 1500 mile range would eliminate the necessity of ICBMs Consequently it was disappointing to see the frequent failures in Polaris tests Several went astray in the air, and one first stage failed to leave the pad while the second stage ignited prematurely and took off across the Cape out of control Once a second stage burning furiously at both ends landed among the palmettos and started a roaring fire on the Cape The tests proved mainly that Polaris and solid-propelled rockets were no easy, automatic answer to the problems of U S rocketry Polaris was not any more exempt from trial-and error type malfunctions than any other major U S rocket It too had to go through its baptism of fire Fortunately, as tests extended through 1959, Polaris performance gradually improved

Two of the most interesting facilities on the Cape were developed to test Polaris One was the gigantic ship motion simulator dubbed 'cocktail shaker," designed to reproduce the motions of the heaving deck of a ship at sea The shaker, mounted in a concrete lined pit fifty-two feet deep was able to reproduce a ship's heaving movement by traveling up and down on rails along the pit walls At the same time pitch and roll could be applied by giant,



A bird s eye view of shaker the ship motion simulator used to test Polaris missiles

hydraulically operated arms and struts The device was strong enough to support the full weight of a loaded Polaris missile but delicate enough its operators claimed to churn a quart of milk to butter or perform a rhumba in time to music Tape recordings made on shipboard during real storms at sea could be fed into shaker so that it would exactly reproduce the motion effect of the storm waves

The other fascinating item of Polaris test equipment was an actual ship, named *Observation Island*, designed to launch Polaris through a deep well in the port side of its forward deck The ship itself was in effect an entire launch complex complete with blockhouse, automatic launch equipment and a broadcast countdown For tests under ideal laboratory conditions the ship could be gyro-stabilized, enabling it if necessary to ride through waves as if on a smooth sea *Observation Island* could also be tilted and maintained precisely at any given degree of heel I once cruised on her for over two hours at a steady list of eight degrees to port In crossing to starboard you had to climb a rather steep hill The list was created by taking on water and was chiefly a safety device to cause a malfunctioning missile to land in the ocean instead of crashing onto the deck

The Cape also served as an outdoor laboratory in the development of nose cones and nose cone recovery techniques As usual the first experiments were military it was essential that the United States develop shapes and materials that would survive the extreme aerodynamic heating as a nose cone hurtles back into the atmosphere Otherwise, the ultimate nuclear warhead might never reach its intended target These shapes and materials were determined at Cape Canaveral by nose cones launched by Jupiters Thors and Atlases The first successful military cones employed the 'heat sink' principle in which a metal shield protected the interior of the cone Following nose cones used the "ablation' principle, which allowed light materials on the rounded nose to use

the heat up by vaporizing It took the United States nearly a year to develop a dependable method of recovering nose cones from the south Atlantic The later cones employed a braking parachute a tough flotation balloon which suspended the cone in the water below, flashing lights a radio beacon yellow dye marker and an underwater explosion device which registered on recovery ship sonar equipment

It was chiefly because of the early faulty recovery techniques that the first nonmilitary experiments were not returned for study Thus two famous white mice named Mia and Wickie were lost in the sea after telemetry data established the important and historic fact that Wickie had survived the impact of reentering the atmosphere In May 1959 a seven pound rhesus monkey named Able and a one-pound squirrel monkey named Baker survived a 1500 mile flight and were successfully recovered

This not only proved that a primate could survive a prolonged state of weightlessness but also established that a monkey protected by a contour bed could withstand reentry forces of greater than thirty Gs (more than thirty times the force of gravity) This G force was far in excess of forces which would react on the first human astronauts to reenter the atmosphere

In addition to mice and monkeys nose cones in biomedical experiments at Cape Canaveral designed to make it safer for the first man to rocket beyond our atmosphere carried such cargo as yeast onions sea urchin eggs and various cultures Nose cones also carried motion pic

ture cameras and in late July 1959 a General Electric nose cone was finally stabilized in flight so that a clear motion picture could be taken of the earth and its cloud cover — an important forerunner of the later weather satellites

By late 1959 most of our first generation of rockets had already proved themselves and had demonstrated that the exploration of space was proceeding at a pace we wouldn t have thought possible just three years before In a few short years the Cape had grown from a small missile test installation into a most important spaceport Both the fiery explosions and the dramatic successes had paved the way for the next great achievement — the substitution of a light and efficient human brain for pounds of complicated electronic data gathering instruments

9

The Second Generation—Vandenberg

WHILE CAPE CANAVERAL emerged from its infancy to become the nation's number one spaceport another rocket base was quietly taking shape on the opposite side of the continent Late in 1956 in a move that seemed to be of only minor importance at the time the Department of Defense had turned over an inactive California Army base to the Air Force Camp Cooke about 180 miles from Los Angeles, was to be used as a launching base for intercontinental ballistic missiles the Department of Defense said in explaining why the World War II Army training base was to be reopened But the Air Force already deeply involved in preliminary studies of outer space had plans that went far beyond ICBM development

By the summer of 1957 the first small contingent of Air Force officers was taking up residence in the small coastal town of Lompoc One of them produced a key for the large padlock on the main gate and Camp Cooke became Air Force property There was little beauty in the raw terrain surrounding the base but like Cape Ca-

naveral it made a near perfect site for launching rockets The base itself was on a point of land jutting out into the Pacific Ocean well north of the dense populations around Los Angeles and with nothing but water between it and the South Pole For putting satellites into a polar orbit, nothing could be better

Cape Canaveral s launching range took advantage of the easterly rotation of the earth to pick up an extra 250 miles per hour for rockets used to thrust satellites into orbit Polar orbits were unattainable from the Cape on a regular basis because the land masses of New England and South America could have been put in danger from exploding rockets or spent stages Polar orbits could occasionally be achieved from the Cape but only after rockets became powerful enough to be launched east ward across the Atlantic, then dog legged to the south Even then, the extra fuel meant severe penalties in total payload weight

So if Lompoc and Camp Cooke, California were not ideal vaction spots their location was nevertheless ideal for certain types of rocket launches A satellite in polar orbit would pass over every point on the earth once each day, as the world rotated below This advantage alone was vital to Air Force plans for "spy-in the-sky surveillance satellites But such esoteric thinking did not appeal to the families of the early arrivals of Camp Cooke "It was desolate and ugly,' said the daughter of one of the officers who reopened the camp 'Everything was the old Army colors

Less than two years later sporting fresh paint, a new

name and the first of many launch pads Camp Cooke became the focal point of strategic military involvement in space On October 4 1958, it was officially dedicated as Vandenberg Air Force Base, our first operational ICBM facility Just eleven weeks after the opening speeches the first ICBM roared up from California soil Despite the fact that the launch date was shrouded in secrecy word leaked out more then 150 reporters and photographers were in Lompoc on December 16 Among them was a young writer named Bob Button What he saw of a totally new and exciting world so impressed him that he resigned his job to become a public affairs officer for NASA

'A *giant Thor missile rose slowly from its launching* pad then leaped gracefully skyward Button wrote 'The sleek 50 ton white bird soared out of sight within two minutes forcing a golden tongue of flame from its tail with a hollow throaty roar'

Later in the afternoon Major General David Wade commander of Vandenberg talked about the successful launching It was the first time that an all military crew had handled the mission he said Preparations had begun at 6 A M the previous day and the launch was every bit as successful as we hoped it would be' General Wade said This will be a regular happening from now on

As if to emphasize the general s prediction, a footnote to the Thor flight occurred at day s end before the eye of reporters who were questioning an Air Force colone about the possibility of launching Atlas rockets from Vandenberg We don t even have an Atlas ' the colone

began But the rest of his statement was drowned out by a noisy truck rumbling past It was pulling an Atlas onto the base The age of rockets sometimes moved faster than the miles of paperwork spun out by the momentum of a new technology

In the early days of space exploration, covering the three years from 1957 to 1960, only thirty seven attempts were made to put satellites into orbit from Cape Canaveral or from its military counterpart at Vandenberg Of these, twenty were total failures The satellites fell back to earth or were blown up Even the seventeen that reached orbit had their share of troubles Some ceased operating almost immediately while components in others left crippled satellites in only partial operating condition

But 1960 turned the tide In twenty-nine attempted missions a record sixteen satellites successfully orbited the earth Their names blazoned from headlines were hailed on radio and television and became part of school lessons Discoverer, Explorer Midas Echo Transit Courier Pioneer and Tiros all broke free of the atmosphere For many of them it was the first taste of success

Millions of Americans stood enthralled as they watched the one hundred foot balloon of Echo I streak across the night sky

From Tiros I Americans saw the first weather pictures of the earth pinpointing cloud patterns over vast areas of the planet With Discoverers XIII and XIV we made recoveries of payloads from space — first plucking a satellite from the ocean then — just eight days later —

snatching another in midair from under its parachute

In 1961 the record was even better, forty-one times the countdown reached the magic zero mark and blazing rockets lifted from their concrete and steel launch pads Twenty nine times the missions were successful As more and more satellites radioed their discoveries back to the earth, the secrets of space yielded up new knowl edge of the void beyond

Pioneer V opened the decade of the sixties along Cape Canaveral s sandy shores Powered beyond the gravity pull of the earth by the slender and reliable Thor-Able rocket the ninety five pound satellite had the monumen tal chore of charting the radiation and magnetic fields be- tween this planet and its neighbor Venus If the mission was successful and the information could be returned scientists would have their first practical look at the haz ards of interplanetary travel

After months of preparation and testing on March 11, 1960 Pioneer V rose gracefully on a strand of Thor-Able flame to disappear into the sky over the Cape Two days later Pioneer V set the first of many communica- tions records by transmitting sc entific data from a dis tance of more than 409 000 miles Its radio was powered by energy from the sun converted to electricity by 4800 solar cells covering the satellite s four extended vanes Shortly before 2 A M on March 18, Pioneer V passed the one million mile mark and radioed back information on magnetic fields cosmic radiation, solar particles micro- meteorite collisions and interplanetary temperatures Then three days later, in one of those lucky breaks that

sometimes aid scientific research Pioneer intercepted a flood of particles thrown outward from the sun by a solar storm and reported their speed volume and radiation level Hours later similar data were received from a pair of Explorer satellites orbiting the earth It was the first opportunity in history to compare the activity of particles racing through different strata of space on the way to our planet Pioneer s transmissions continued until June 26 when the final signals were received from a record distance of 22 5 million miles Now long dead the little satellite continues to orbit the sun completing a year every 312 days and waiting perhaps for the day some future astronaut retrieves it to be displayed in a museum as an obsolescent relic of the past

There was little joking among space watchers at Cape Canaveral on April Fool s Day of 1960 For that was the day planned for another important step into space this time to put the advantages of an orbiting satellite to work for the people on the earth The satellite was Tiros, an acronym for television infrared observation satellite, the world's first orbiting weather station Again the Thor Able rocket combination was called upon, but this time only to reach a near-circular orbit of about 450 miles And again everything was ' go' from the very beginning starting an unbroken chain of Tiros successes

The eighteen sided Tiros satellite which weighed around three hundred pounds looked like a lady s oversized hatbox

From the bottom center of the Tiros hatbox' protruded the lens of a camera and four slender antennae

In the three months during which the weather satellite operated — April through June 1960 — ground stations received a phenomenal total of 22 952 pictures of the earth s cloud cover The eagle eyed Tiros even spotted a tornado storm system near Wichita Falls Texas on May 19 giving added proof that meteorologists now had a most advanced new tool available for reporting and forecasting the weather

Throughout the spring and early summer space feats continued both from the ' open pads at Cape Canaveral and from the 'secret' military launch facilities at Vandenberg Air Force Base The Navy s Transit I B became the world s first navigation satellite a beacon for ships at sea, especially useful to submarines And the Air Force put a supersecret Midas satellite into orbit, a spy in the sky equipped with sensitive devices to detect the launching of an enemy missile and flash a warning as it left its pad

The Navy came back before the half year ended with its Transit II A an improved navigation satellite that could become the forerunner of an entire network of orbiting beacons to give ocean going ships the capability of pinpointing their location without using sextant or the sometimes unreliable loran devices Even more important, riding in tandem atop the Thor Ablestar rocket was a second Navy satellite to measure radiation It was another step forward the successful orbiting of two satellites at once The technique would become increasingly useful in the years ahead

Of all the months in 1960 and 1961, that first August stands out as the brightest for unmanned satellites In the eight short days from August 10 to 18, long months of trial and error, launch and failure were suddenly rewarded with a trio of astonishing successes For a year and a half, the Air Force had been attempting to recover data capsules ejected in orbit from its semisecret Discoverer satellites In the capsules, complex data were recorded on magnetic tape but for months none of the rolls of tape could be recovered The first data capsule crashed to earth near Spitsbergen in April 1959 Others were lost at sea

Then came the break! Discoverer XIII was launched into an orbit of 431 miles by 157 miles by a Thor-Agena rocket on August 10 from the Air Force s closed pads at Vandenberg It circled the earth seventeen times, recording valuable information on propulsion, communication and satellite stabilization At the end of the seventeenth orbit, radio signals triggered the ejection mechanism and a three-hundred pound capsule fired away from the satellite With cannonlike accuracy, it reentered the atmosphere to drift safely under its parachute to a gentle landing in the Pacific Ocean, where men gleefully pulled it aboard one of the waiting ships For the first time a capsule had orbited in space and had safely returned! With it, the Air Force said came more than four times as much data as had been radioed back by any other Discoverer

Early the next day on the other side of the United States, a Thor-Delta rocket lifted away from Cape Ca-

naveral Tucked neatlv into its nose cone was a delicate package soon to become the most brilliant object in the night sky Reaching its nearly circular orbit about a thousand miles above the earth the package popped out into the vacuum of space Then a strange and wonderful thing happened A power inside the package reacted to the vacuum by turning into a gas As this sublimation occurred the package expanded to become a shiny silver balloon full one hundred feet in diameter Named Echo I the balloon was a passive communications satellite whose gas filled skin was only one half the thickness of the cellophane around a pack of cigarettes In the following months before its shape was altered by leaking gas hundreds of telephone conversations and other radio transmission experiments bounced off its silvery hide to be relayed from station to station A wirephoto of President Eisenhower was beamed to Echo from Cedar Rapids Iowa and picked up by a receiver in Dallas Texas Every night millions of people around the world gazed in wonder at Echo tracking across the sky Because of its high visibility it was the first man-in the-street satellite Since its appearance in the sky could be accurately predicted thousands of people went outside on clear nights for an 'Echo watch Once in Washington D C while I was attending an outdoor performance by the comic pianist Victor Borge the master showman arranged to be signaled at the exact moment Echo appeared on the horizon On cue he got up from his piano pointed out Echo then casually lighted a cigarette and along with his audi

ence watched its passage for several minutes Otherwise he knew he would have had to perform to row upon row of Adam s apples Echo I was the first proof to the naked eye that man's devices and ultimately man himself were no longer prisoners of the atmosphere

Last of the August successes came on the eighteenth when the Air Force pulled yet another coup with its Dis coverer satellite Launched from Vandenberg, the satellite s three hundred pound data capsule was ejected the same day Exactly on target 360 miles southwest of Ha waii Captain H F Mitchell circled above the calm Pacific with his crew in their specially equipped C 119 transport plane Then they saw the object of their mis sion above them The Discoverer capsule back from space drifted slowly down Its colorful red and white parachute made a perfect target Extending a long hook and cable from the transport's door the excited crew made ready Captain Mitchell made his pass at the return ing spacefarer A small jolt told him the story the data capsule was snared ten thousand feet above the water Switches were thrown to power up the winch and in moments Mitchell s crew had the important package safely aboard In record time the capsule was on the ground in Hawaii

The importance of such midair catches can be judged by the Air Force s refusal to discuss them after their ini tial successes As more and more sophisticated satellites went into orbit under a ' secret" label the Air Force said less and less In late 1965 a writer asked Frank Burnham,

a top level information officer in the Air Force Space Systems Division if returning payloads were still retrieved in midair

"Are you asking me or telling me?" Burnham replied

I m asking

'No comment Burnham said It was the best indication under security restrictions, that early lessons had indeed been learned well

10

Alan Shepard—the First American in Space

ONE OF THE MOST astonishing aspects of modern science is its ability to move so rapidly that virtually all prophecies and predictions turn out to be too conservative Few if any, of us who fished at Cape Canaveral before it became a rocket base would have thought it even remotely possible that America would be ready to send a man into space as early as 1961 Yet just after midnight on Friday May 5, 1961, a blue eyed thirty seven-year old astronaut named Alan Shepard was getting his last hour of sleep before he would be awakened to make the attempt

From my position, sitting in the cool sand of dark and empty Cocoa Beach, I could easily see the spotlighted Mercury Redstone 3 rocket that was scheduled just after dawn to try to launch the first American into space Seven miles across the water the low, flat silhouette of Cape Canaveral jutting into the calm Atlantic glowed like an island city as thousands of ground lights reflected off the slight haze that floated in from the surf Here and there were constellations of lights around various launch

complexes, and rising from the light clusters were scores of massive red and white service structures, some of which were floodlighted and some of which were just outlined by their red aircraft warning lights But the dominant object on the Cape was the specially built Redstone rocket standing alone on pad 5 It was being groomed for the most important flight old reliable Redstone had ever participated in A battery of sixteen powerful searchlights converged on the white rocket giving it the dramatic illumination of a monument Some of the shafts of bluish light streaked far overhead in the dark *sky as if pointing out the rocket s path into space*

Three nights earlier I had also sat at this spot and watched the same rocket being prepared for launch but *then I had seen ominous lightning over the ocean* That flight had been scrubbed at 7 25 A M because of darkening weather after Alan Shepard had waited over two hours inside the nine and a half by six foot spacecraft he had named Freedom 7 So far tonight the weather looked good The wind was out of the southeast about ten knots Seas were running two to three feet high at Cape Canaveral and only a foot or so higher near the Grand Bahama Island impact area where Alan was scheduled to parachute into the ocean the next morning if all went well

Behind me three hundred yards beyond the mounds of sand dunes with their sea oats swishing in the night breeze I could hear muffled music from the Holiday Inn Motel where astronaut Virgil Grissom was now taking a

quick catnap In a few more hours we'd all ride up the Cape for the launch The music was coming from the Riviera Lounge, where the We Three Trio were again singing a special song they had written for the astronauts When the song ended with the staccato countdown there were the usual cheers and applause from newsmen and others who were waiting out the long night Altogether 534 reporters photographers, commentators and various news media technicians were on hand Some were old time birdwatchers whose companionship I had shared in the early days while sweating out the first Atlas launches the Vanguard program the magnificent launch of Explorer I — the first U.S satellite — the various moon probes and many other shots that had become milestones during the brief span of U S space history We had also witnessed the tragic explosion — the baptism of fire — that had ended many a launch We knew what the risks were

Most of the old-timers — from *Life*, NBC, CBS, the *New York Times* and other daily papers — were more than professionally involved in this shoot It was a highly personal matter — especially among those of us who had gotten to know Alan Shepard as a modest yet confident, superbly trained dedicated astronaut

While I waited on the beach I reviewed Alan's schedule for the remainder of the night I knew it by heart Several days earlier I had watched astronaut Gordon Cooper take his physical exam put on his shiny silver space suit and go through the suit pressurization tests

Everything was planned for Alan according to the same schedule Gordo Cooper and the other six astronauts had helped standardize

At the moment Alan was sleeping in the bottom portion of a double deck bunk bed in a small robin's egg blue room on the second floor of hangar S inside Cape Canaveral The astronauts personal nurse Air Force First Lieutenant Dolores (Dee) O'Hara a pretty brunette told me she had selected the wall color herself, as well as the champagne colored drapes and cinnamon-colored furniture "To me they are relaxation colors, she said and on the night before the shoot I want them to relax"

She used the word 'them' because another astronaut John Glenn was sleeping in another bunk bed in the room with Alan, in case one of the doctors or psychologists or Alan himself ruled that a substitution should be made at the last minute During the past month I had frequently seen John Glenn in white shorts and T-shirt, sprinting on the beach before breakfast He disciplined himself to run two miles every morning just so he would be in condition in case he was the astronaut selected for the first flight Project Mecury officials had others to choose from, but it was unlikely that Alan would allow anything to keep him from making the flight

A week earlier chief astronaut physician Dr William Douglas had told me We'll scratch the selected astronaut only if he has appendicitis or something seriously wrong with him As far as I'm concerned they can go to bed whenever they feel like it If they don't sleep, it's

O K I don t plan to give them any sedation sleeping pills or anything like that "

I hoped Alan was sleeping well At that moment a lonely car — containing another nonsleeper like myself — drove down the hard packed coquina sand of Cocoa Beach In the glow from the flickering headlights I saw a straw-colored sand crab scurrying sideways for its hole I glanced at my watch 1 45 A M Alan would be awake now He and John Glenn would have showered and shaved and would be getting ready for their low-residue breakfast of orange juice, seven ounce steak filets wrapped in bacon two poached eggs and dry toast with jelly During breakfast, hovering around them — attentively but not obtrusively — would be Dr Bill Douglas Dee O Hara and a second dedicated physician Major Carmault Jackson, whom many of us knew as just Jack

After breakfast and the detailed physical exam Alan would put on his thermal underwear, a set of specially designed long johns containing built-in pads of highly porous material At first the underwear would be rolled down to his waist, revealing four small purple marks tattooed on his chest to provide exact reference points for the attachment of the four wires which would measure his heart reaction in flight Another astronaut doctor Stan White, sitting comfortably in Mercury Control Headquarters would actually watch Alan's heartbeat on an oscilloscope while he was in flight

The four orange wires — called EKG (electrocardiogram) sensors — are glued and taped to the tattoo marks

on Alan's chest Then a fifth wire containing a small gray respirometer to measure the rate of breathing is taped to his neck The final wire leads to a deep body temperature probe which is inserted into his rectum He now slips his arms into the upper portion of his thermal underwear leaving his waist button open so the six wires can lead out to a small metal disc which is later plugged into his space suit As he walks along in his long underwear holding in his left hand the umbilical like wires dangling from his midsection he is a strange and almost comical looking spaceman and Alan would be the first to grin over his appearance But these measurements are of vital importance

After the wires are tested Alan walks into the adjoining pressurization room where suit technician Joe Schmitt of O Fallen Texas carefully holds in his hands the $2700 thirty pound (including helmet) space suit Alan told me one day they didn't like to refer to it as a space suit "It sounds too Buck Rogerish We call it a pressure suit

Nevertheless the gleaming silver garment with the NASA emblem and Shepard s name tag on the right breast looks for all the world as a space suit should It is of handmade precision construction from its clean white helmet to the shiny silver boots that are snugly closed with both zippers and laces The gloves are even made with built in curls in the fingers to better enable the astronaut to grip his control levers in flight The weight comes from the fact that the suit has two layers — alumi

nized nylon on the outside and a thicker layer of rubberized nylon called a 'rubber sock' on the inside

Now Alan must begin the difficult job of getting into the formfitting suit It s a two man operation First, he sits down and inserts his right leg as far down as it will go It is several minutes before he and Joe Schmitt, struggling together, are able to work his foot all the way down to the black rubber stocking Then the process is repeated with the left leg, using special pulling straps attached to the sides of the suit Just before the suit is pulled up to waist level the metal disc where the orange wires terminate is plugged into the bottom side of a metal plate on the upper right thigh The company which designed the suit (B F Goodrich of Akron, Ohio) even sewed in a small elastic band at the end of each sleeve of the long underwear Alan now hooks these bands over his thumbs so the underwear sleeves will not ride up as he shoves and twists his arms into the arms of the space suit

The next part of the operation is the most difficult of all — getting the metal neck ring over his head (The helmet later will be screwed into this neck ring) Alan and Joe working together pull tug and twist the suit as far upward as it will go then Alan tilts his head far forward as Joe forces the ring over it By now, Alan — to judge from Cooper s reaction, which I had watched earlier — is breathing heavily and probably beginning to sweat

But the worst is over The suit is zippered up, straps and harnesses are tightened, and the silver gloves and boots are attached Plastic bootees are then placed over the

boots so Alan will not track any debris into the capsule After the round white helmet is lowered over the head like a fishbowl it is twisted into place and secured, and the astronaut walks somewhat stiff-leggedly across the room and climbs into his personally tailored formfitting couch which precisely matches the one waiting for him in the Freedom 7 capsule He snuggles into the couch lying on his back The couch supports his thighs at an upward angle, from the knees down his legs are horizontal so his feet will fit naturally into the foot clamps Joe Schmitt now tightens

It takes Joe seven minutes to strap the astronaut securely to the couch Next Joe plugs a heavy-duty pressure hose into the stomach valve on Alan s suit attaches a small white oxygen outlet hose to the left side of the helmet and lowers the transparent helmet visor

'Ready for pressurization . Joe says into a microphone and the astronaut answers him by speaking into the two mikes inside his helmet As Joe turns the pressure valve on a nearby instrument panel there is a hissing noise and the astronaut wiggles his feet and pumps his hands and arms to assist the entry of air pressure The gloves swell and stiffen as the astronaut flexes his fingers Gradually the suit fills until the pressure reaches the desired five pounds If no leaks develop after five minutes Alan is free to wait and relax The air entering his suit is cooled to keep him from overheating He can keep the helmet visor closed and rest comfortably on his back breathing fresh oxygen

I wondered what would occupy his thoughts It

wouldn't be natural if he didn't feel some apprehension, all test pilots do, and on this flight he was essentially a test pilot as he had once been for the Navy before he was selected as a Project Mercury astronaut He had also survived some hazardous flying from a carrier off the coast of Korea Once he had made a difficult carrier landing in darkness and fog with no radio aids This morning's flight was the product of his entire background

Commander Alan Shepard was born November 18 1923 in East Derry New Hampshire where his father, a retired Army colonel is now an insurance broker After graduating from Admiral Farragut Academy, Alan attended the Naval Academy at Annapolis and received his commission in 1944 After Pacific service during World War II on the destroyer *Cogswell* he elected flight training, and received his Navy wings in 1947 Subsequently he flew or tested the following aircraft F2H3 Banshee, F3H Demon, F8U Crusader, F4D Skyray and the F11F Tigercat Altogether he logged over 3700 hours of flying time of which more than 1800 hours were in jets

As he waited for his call to the launching pad Alan Shepard would reveal no outward sign of apprehension During preparation for the Tuesday flight which had later been canceled because of bad weather, Air Force Lieutenant Colonel John Powers the Project Mercury public affairs officer, said he had never seen Alan calmer and more relaxed as he went through the carefully rehearsed preparations for the flight Alan would be in good control of himself as always yet the importance of his role couldn t possibly escape him He was sched-

uled to be the first American to achieve weightlessness in space He had been carefully, even rigorously trained Teams of doctors, scientists and technicians were already deployed all over the United States and downrange to assist his mission and millions of dollars had been poured into the Mercury program National pride and national aspiration were at stake It would be remarkable, indeed, if Alan Shepard did not feel he was about to embark on the most important day of his life

From my position sitting on the beach I watched the searchlights wink out temporarily around Alan s Redstone rocket This was a period of waiting for the rocket too The night seemed cooler and darker I wondered if the breeze was rising I could still see the glow of lights behind me where other newsmen were waiting in the motel for the buses that would take us inside the Cape

I thought of the contrast to the first powered aircraft flight at Kitty Hawk North Carolina — just fifty-eight years before Then no reporters had been present In fact, one of the participants had had to walk four miles to send word to Dayton Ohio that a man had actually flown in a powered airplane Now there were over five hundred of us assembled at Cape Canaveral with over a million dollars in equipment and leased wires ready to send the details to a waiting nation

There was another important contrast to Kitty Hawk Orville Wright had not only been the first American to achieve power flight he was the first man on earth to do so Even if Alan Shepard were successful he would not *be the first man to achieve space flight As the whole*

world knew, he had been preceded only twenty-three days before by a handsome twenty seven-year-old Russian major named Yuri Gagarin

This, too may have been in Alan s thoughts I knew how desperately he and all our astronauts had wanted us to be first

When word arrived in the United States on April 12 that Russia had succeeded in orbiting and recovering alive Major Yuri Alekseyevich Gagarin I was having breakfast in Chicago My first thought on hearing the news was 'What do our own scientists and astronauts think of this — how do they evaluate it?'

The fastest way to Cape Canaveral was a nonstop jet to Tampa on the Gulf, combined with a fast ride in a rented car across Florida to the Cape on the Atlantic At the airport I bought five newspapers and settled down on the plane to study the details The Russians were playing things as usual pretty close to their chests No Western newsmen had been allowed to witness the shoot Information was sketchy

The Communist Party announced that a satellite spaceship named Vostok (meaning East) had been launched on April 12, at 9 07 A M Moscow time, and had circled the globe once with Gagarin aboard Gagarin, the Russians said had landed safely in Russia 108 minutes later Few other details were announced

Several people on the plane were doubtful that the shoot had actually taken place I was sure Gagarin had actually made the flight when I noticed that a portion of the announcement had been made by Professor A N

Nesmeyanov of the Soviet Academy of Sciences Once in Washington I had talked to our Russian speaking expert on Soviet space affairs He read translated and evaluated everything the Russians had ever claimed about space activities This was his life s work

Never trust the Communist Party announcements he told me but if this fellow Nesmeyanov says it is so it probably is I have never caught him in a lie or even an exaggeration

Since then I had carefully studied some of Nesmeyanov s translated speeches and articles and had also discovered that he seemed to be commenting factually as a scientist not as a propagandist I knew also it would have been impossible for the Communist Party to hoax or fool its own scientific fraternity for long The word of a hoax would sooner or later come out and would react seriously against its authority

My jet was flying south at an altitude of twenty-eight thousand feet We were in the clear cold air above the dust fringe of our lower atmosphere At that altitude the sky above was much darker than normal I could barely see the surface of the earth through the haze and the occasional patches of faintly orange clouds far below It occurred to me that someday in the not too distant future the planet Venus with its very moist atmosphere might look something like this to an astronaut approaching it I also wondered how the earth must have looked to Gagarin the first man to see it from the lofty realm of space I knew our astronauts had held many discussions — had even bet among themselves — on whether or not

the first man in space would be able to see the stars in the daytime I wondered if Gagarin had been able to see them

When we landed at Tampa I raced in to buy late papers to try to find out what Gagarin saw and felt These and later reports provided some of the details of Yuri Gagarin s historic 108 minute space ride

One of the first revelations he made was that he had seen the stars on the daylight side of the world He told his audience in the House of Sciences in Moscow, 'I could see the stars very well They were bright and distinct Nesmeyasov said the Russian spaceman s first words from space had been, "How beautiful it looks"

This is how Gagarin described man s first view of the world from space "I could see the daytime side of the earth very well The shores of the continents islands important rivers great water surfaces, ridges and cities were clearly distinguishable From a spaceship visibility is, of course, not so good as from a plane but it is still good and even very good

During the flight I was able for the first time to see with my own eyes the spherical shape of the earth You can see it when you look at the horizon The view of the horizon was different up there and very beautiful You can see a beautiful transition from the bright surface of the earth to the completely dark sky, in which the stars are visible This transition is very subtle It is as though a film ringed the earth It is of a delicate blue color This change from the blue to the dark is very gradual and lovely It is difficult to render it in words

'And when I emerged from the shadow of the earth, the horizon looked different There was a bright orange strip along it which again passed into a blue hue and once again into a dense black color In space the sun is shining tens of times brighter than it is seen from the earth '

One of the most significant facts Yuri Gagarin revealed, as far as our own astronauts were concerned, was that he encountered no difficulty with weightlessness He said ' Legs and arms weigh nothing Everything was easier to perform Objects were swimming in the cabin Myself I did not sit in the chair as before but was suspended in midair During the state of weightlessness I ate and drank I was noting my observations My handwriting did not change though my hands was weightless But it was necessary to hold on to my writing pad or it would have floated away I could have gone on flying through space forever '

I was still pondering Gagarin s space flight as I drove in to Cocoa Beach just outside Cape Canaveral After Gagarin s flight which had carried a human being higher (203 miles) and faster (18 000 miles per hour) than ever before I wondered how our own astronauts Gordon Cooper Alan Shepard Virgil Grissom, John Glenn, Donald Slayton Scott Carpenter and Walter Schirra, would react For weeks they and hundreds of other Project Mercury personnel had been working feverishly, hoping to be first Most of us had assumed the Russians would attempt to send their first man into space on May 1 their national holiday In those first few days of April

it had suddenly looked for the first time as if we might beat the May 1 deadline and be first in space But the Russians had launched Gagarin on April 12 — nineteen days before May Day — and they had succeeded magnificently When the Russian rocket went up our own space booster, the MR-3 (Mercury Redstone number 3) was already being prepared on pad 5 Three of our astronauts, Alan Shepard John Glenn and Virgil Grissom, were ready and eager to go They were devoted and patriotic professionals, they wanted desperately to be first

As I drove in to the palm studded grounds of the ninety nine unit Holiday Inn Motel where the astronauts were staying I noticed that press preparations were already under way Wires were being strung out like spaghetti along the sides of the motel These were to supply the extra power for the teletype machines and photographic laboratory equipment being installed for the use of the press Some friends of mine had already chartered one single-engine and six twin engine planes to help get the film out faster One photographer was making daily calls to the local police trying to get a police escort to speed him through the crowds expected on our shoot day A sign on the window of room 104 read OFFICE, TELEVISION POOL, PROJECT MERCURY ABC, NBC, CBS Dick Billings of *Life* had been there for days working on photographic arrangements in a motel room he had outfitted as an office This was only one day after Yuri Gagarin s flight The unofficial race between the United States and Russia to launch the first man into space had been just that close

That night as I had dinner with two of our astronauts

and other members of Project Mercury I was not quite prepared for their reaction I had anticipated they would be disappointed but I had miscalculated their highly personal involvement in our own program It would not be fair to reveal their names as the discussion we had over roast beef in Cocoa Beach's Ramon's Restaurant was as it is called in journalism, not for attribution

One astronaut, whom I had often talked to on previous shoots at Cape Canaveral said in the last twenty days some field members of Project Mercury had been working up to seventy hours a week trying to get ready in time Some of them he said, 'are just groggy on their feet There may not be a race going on in Washington but among us worker bees we ve been racing our heads off But it is strictly a workers rebellion, without too much support from the top We all know we could have put a man up there two months ago if two years ago somebody in Washington had just decided to push it I ve never felt so let down in my life

Said one of the astronauts numerous doctors All of us in the field have been in a race But the top brass and the officials have been dragging their feet If the *Santa Maria* had been handled and outfitted that way it never would have left the harbor '

Said another astronaut 'One of the chief things that held up our program was the belief in some high levels that the United States didn t need any astronauts at all All they needed some said was enough electronic gear and black boxes aboard our rockets to report back how it felt to be in space That s like Queen Isabella sending a

ship to America with instruments aboard designed to tell her what the American Indian looked like" Then he added thoughtfully, "Well, there s one good thing about Gagarin s flight It proves there is no serious obstacle to a man going into space Despite all our instruments, we really didn't know this before Maybe we ought to be happy to know that it can be done

During the next three weeks leading up to Alan Shepard s flight I was often with the astronauts or other members of the Project Mercury team Gradually, as they became absorbed in our own preparations and in their individual training bitterness over our loss of the race to put the first man into space faded into the background They were concentrating on putting the first American into space

During off duty hours the astronauts fished in Port Canaveral harbor or relaxed around the motel pool Each day brought us closer to our first flight and finally the day arrived when the countdown began The night before the launch as I sat out on the dark sand and studied the great rocket on the Cape, nothing anywhere in the world seemed more important than a safe and successful ride for Alan Shepard A few minutes before I left the beach four boys ages sixteen to nineteen drove up and pitched two pup tents in the sand They had just arrived after a fast drive all the way from St Louis Missouri One of them said 'I didn t think we'd make it in time Man am I glad to be here to see this flight

I glanced at my watch 3 20 A M It was time for the buses which would take us to the Cape

Just before sunrise, our blue Air Force bus stopped at the south gate of Cape Canaveral A Pan American policeman climbed aboard checked each press badge then waved the bus forward There is a contagious air of excitement that pervades a vehicle that has just passed the Cape security gate As the bus rumbled on I leaned forward and eagerly studied the familiar gantries for Thor, Redstone Atlas Jupiter and Titan rockets Through a low place in the palmettos I could see the top of the ship motion simulator At the far north end of the Cape was a truly gargantuan service structure — the newest and by far the largest in the free world This was the gantry being prepared to launch our mighty Saturn rocket which someday would attempt to take an astronaut to the moon And scattered all over the landscape were strange and futuristic looking antennae theodolites and radar screens

But on this day the morning of May 5 1961 the center of attention was a Redstone rocket already loxing on pad 5 You could see the spume of lox vapor floating away from the rocket The huge tower had moved back around the rocket and the red elevators were working up and down on the sides Our bus stopped at the press camp and photography towers located about a mile from the pad At the base of the tower were row upon row of huge silver air conditioned TV vans and trailers humming in the cool morning air Wires and cables were strung out on poles and on the ground in the manner you sometimes see at circuses or carnivals

The circuslike air — which was accentuated by the

presence of canvas additions to some of the trailers — had not escaped the sharp eye of astronaut John Glenn The day before, he had walked through the area shaken his head thoughtfully and said, ' All they need is some sawdust a camel and an elephant

I checked immediately on the status of the countdown at the small press shack which had direct communication to the blockhouse and to Mercury Control At 5 07 the count was T minus 140 minutes and counting The MR-3 rocket was almost on schedule just two hours and twenty minutes from launch

A few minutes later, at 5 15, the bright yellow disc of the sun edged up from behind a cloud bank over the ocean Here and there on the flat Cape scrubland were patches of ground fog and as the sun s rays touched our particular exciting part of the earth the ground fog suddenly turned a rosy-gold color Everywhere about the press camp was a hushed air of anticipation and hope — as technicians strung out wires, reporters alerted their offices over long distance and photographers fiddled with their tripods and cameras atop the wooden press tower Japanese German English and French reporters mingled with Americans who represented every major publication in the United States

The weather looked fifty-fifty just a few clouds floated overhead at 2500 feet, but the cloud bank over the ocean looked dark and ugly The wind was from the ocean at about eight knots

I knew Alan had safely passed his early morning physical and was already at pad 5 Inside a tent beneath the

press tower a bank of TV screens were already playing back the TV record of his trip from hangar S to the rocket Later a friend of mine Ed Reingold, reported the sounds and 'color —background and facts—to go with the pictures on the TV monitors

At 3 30 A M Alan came out of the south door of hangar S, holding his black portable air conditioner in his right hand His silver space suit gleamed and sparkled in the camera lights Earlier just before he closed his visor his last words to his very nervous nurse Lieutenant O Hara had been Here I go Dee As he walked stiff leggedly to the big van he looked straight ahead neither blinking nor smiling His lips were closed and relaxed behind the two small rectangular microphones inside his helmet He stepped up into the waiting van along with astronaut Virgil Grissom (dressed in a sport jacket) pressure suit technician Joe Schmitt and his two doctors Bill Douglas and Jack Jackson As Alan settled into a formfitting contour couch that was an exact duplicate of the one in the Freedom 7 capsule Grissom patted him on the back Then the doors were shut and the big van headed for the launch pad two miles away

Waiting at pad 5 were Dr Wernher von Braun and Dr Kurt Debus Close up the rocket looked and sounded like some awesome denizen of outer space As the frigid liquid oxygen (minus 293 degrees Fahrenheit) rushed through the pipes the conduits and fittings gave off unearthly squeals that sounded like the insane trumpetings of a herd of frightened elephants In the brief intervals between the squeals of the complaining pipes ob-

servers could hear the whirring and pumping of the generators and compressors Great clouds of vapor vented off the sides of the rocket and whirled eerily around the cluster of hard-hatted men working at the rocket s base The entire lower half of the rocket, which contained the ice cold lox tanks, was coated with a rime of frost that was gradually thickening From time to time a wind gust showered the men working below with a spray of soft ice flakes There was so much ice on the rocket that the entire word STATES of UNITED STATES printed on the rocket in huge letters was covered up

The van carrying Alan Shepard arrived at pad 5 at 4 27 A M At 5 14 the doors opened Alan stepped down stiffly his motions were obviously hampered by his tight thirty pound pressure suit He took a few steps forward then shading his eyes from the glaring searchlights, he gave a long look at the tall rocket Apparently satisfied, he let Bill Douglas and Gus Grissom assist him into the elevator Then he took the thirty two-second ride to the top of the rocket, fifty eight feet above the ground Inside the 'greenhouse, a sterile air-conditioned room surrounding the capsule, a technician helped him remove the plastic coverings from his boots Then Alan walked across a sterile white nylon rug to the capsule where astronaut John Glenn briefed him on how the capsule checked out For over two hours Glenn dressed in white coveralls had sat in the capsule checking and double-checking instruments and equipment He told Alan everything was working perfectly

Alan climbed into the cramped instrument-jammed

capsule which astronauts sometimes called the tele phone booth and established radio contact with astro naut Donald Slayton Deke Slayton was located in Mercury Control Headquarters and was Alan s primary voice contact on the ground Deke s console was known as capsule communicator or just cap com At 6 10 A M the side hatch was carefully sealed on the Freedom 7 spacecraft and Alan Shepard was on his own

At the moment we got word at the press camp that the hatch was closed the count was T minus 77 minutes and counting Weather was still marginal clouds off the ocean were building up fast A few moments later we heard four mournful blasts of the powerful horns at the pad which are the final warning for everyone to either enter the blockhouse or leave the area

A few moments later the giant gantry moved slowly away from the rocket on its wide gauge railroad tracks We could now see the bright red paint on the three escape rockets and the latticed tower which connects the escape rockets to the capsule Now an awkward looking, gangling and elbowed yellow crane, called a cherry picker maneuvered ponderously near the rocket and very carefully and delicately positioned its small cab next to Alan s hatch on the side of the capsule

Both the escape rockets and the cherry picker were realistically designed safety features to protect the astro naut s life in case anything went wrong Alan had three chances to save his life if an accident occurred in launching If the rocket should explode suddenly the capsule would be instantly jerked free by the discharge of the

escape rockets The rockets would take the capsule and Alan straight up for nearly a mile Then the escape rockets and the connecting tower would be separated from the capsule and a huge parachute would float the spacecraft back to a landing

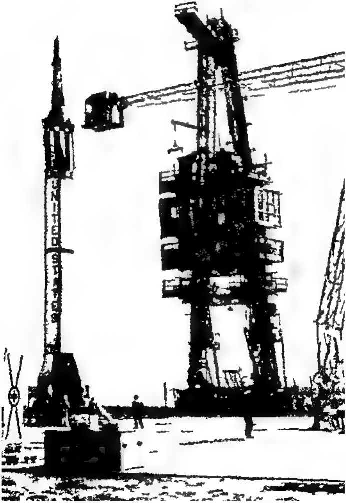
I had confidence in this escape system and I knew Alan did A week before, I had watched an Atlas rocket take off with an empty capsule aboard The rocket was supposed to boost the capsule into an earth orbit but something went wrong with the Atlas just after launch It blew up before our eyes The instant we saw the giant explosion expand in the sky a streak of smoke darted upward from the ugly orange fireball and a moment later a red and white parachute blossomed well above the falling debris The chute suddenly appeared dangling the capsule below Spectators cheered and clapped because the proof was there for all of us to see that if an astronaut had been aboard when the explosion occurred he would have survived

Later, as I was inspecting the undamaged capsule which had been plucked from the water by a helicopter I saw Alan among the group of scientists and technicians walking studiously around the capsule which was still making spitting sounds as steam escaped from its hydrogen peroxide jets Shepard was standing alone, bareheaded wearing a white shirt with unbuttoned collar His expression showed not the slightest fear even though he already knew he had been selected to make the first flight He seemed lost in an utter and intense privacy He was frowning in concentration and his bright blue eyes were

serious and thoughtful as he continued to stare at the capsule still wet with seawater All the rest of us had witnessed the explosion and successful recovery as impersonal spectators But Alan's viewpoint was unique and of course highly personal It was his capsule and his own life that depended on the perfect functioning of the escape system

There were two other ways Alan could leave the grounded rocket if an emergency occurred One of course was through the cab at the top of the cherry picker if time permitted The other was not pleasant to contemplate but if it should happen that the rocket exploded or toppled to the ground and the escape rockets failed to go off there was another safety device concealed nearby that neither the public nor the press had been told about This was a specially equipped Army tank that had its metal plates coated with heat insulating material The tank crew were prepared to move right into the flames if necessary to attempt to bring Alan out alive

The count crawled slowly toward the moment of fire At 7 14 the count was halted abruptly at T minus 15 minutes because the clouds had thickened to the point where visual observation of the rocket and optical tracking would have been impaired And during the hold as often happens with highly complex rockets something else went wrong A small inverter (which changes the twenty eight volt battery system to a four hundred cycle alternating current) began to drift badly Once again the tower rolled back up to the rocket so the hot


UNITED STATES

inverter could be replaced Throughout Alan remained inside the capsule strapped on his back I watched on the TV monitors as white suited McDonnell engineers plugged external lines into the capsule beside the letters FREEDOM 7 to keep Alan s life support system functioning during the repairs

After the tower pulled back and the cherry picker once again moved into position there were two more brief delays a temporarily faulty computer at 9 01 then a faulty pressure regulator inside the capsule stopped the count at an agonizing T minus 2 minutes 40 seconds Alan had been inside for over three hours As I nervously paced around the press camp or alternately, studied the fuming rocket through binoculars I knew very well what the delays were doing to the nerves of the mere spectators I wondered how Alan was holding up The pressures on him must have been tremendous

At 9 32, with just two minutes and forty seconds to go the count resumed and as if on a schedule the clouds rapidly began to disappear A minute later as the cherry picker backed clumsily away my friend Chuck Von Fremd of CBS with whom I had watched many a shoot came up to me and wiped some sweat off his brow We didn t say anything at first I knew he was a friend of Alan Shepard s "Well Chuck said finally Alan is on his own now'

T minus sixty seconds the loudspeaker squawked

The rocket stood alone on the great flatland of Cape Canaveral Hundreds of cameras and thousands of pairs of eyes pointed straight to Freedom 7 In the silence you

could hear the small birds chirping America stood on the ramparts of space

"Thirty seconds *The umbilical boom fell away from the rocket as scheduled Overhead two jets — one at five thousand feet piloted by astronaut Wally Schirra and one at twenty thousand feet piloted by astronaut Scott Carpenter — roared into observation position No one on the ground moved*

"Twenty *I glanced over my shoulder There was a row of thirty-five reporters standing at outdoor phone booths One hand held an open phone The other was used as an eyeshade against the morning sun The witnesses waited Alan Shepard's heartbeat thumped rhythmically on the oscilloscope in Mercury Control His pulse rate was 139 beats a minute*

"Ten nine eight *A photographer cursed a man who was suddenly running, imperceptibly shaking the giant wooden camera tower*

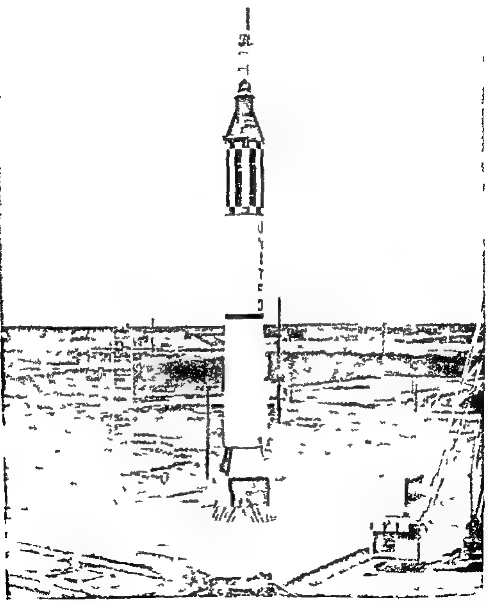
"Three two one Ignition!" *A tiny increment of orange-colored smoke at the rocket's base turned instantly and silently into an exploding fountain of fire*

"LIFT OFF!

Freedom 7 began to move — slowly, gracefully, majestically Instantly the strong, precise voice of Alan Shepard flooded reassuringly into the headphones of Mercury Control Personnel

"*Roger, lift off!" he stated emphatically "The clock is started"*

As the slender rocket carried Alan Shepard three, four,



Redstone lifts off carrying Alan Shepard
on the first U.S. manned space flight

five rocket lengths above the earth a natural and thrilling contagion spread through the ranks of newsmen and spectators Somebody started to clap, it was picked up magically Instantly there was a crescendo of claps and cheers and shouts of 'Go, go go!' "Keep going! Keep going!' 'Please keep going! Please Lord, let it go!'

It went

When the roar of lift-off and ascent finally slammed against the witnesses in the press camp Alan Shepard's steady, strong voice continued to pour out of the rising rocket He was already feeling the G forces of acceleration and his voice had a slightly grunted, staccato quality He reported facts and figures, the vocabulary of science, like a trained test pilot His buoyant busyness and calm confidence anticipated no accident Astronaut Deke Slayton acknowledged periodically from his console in Mercury Control

SHEPARD This is Freedom 7 Fuel is go Cabin pressure holding at five point five

SLAYTON I can understand Cabin holding at five point five

SHEPARD Oxygen is go The main buss is twenty-four The isolated battery is twenty nine

SLAYTON Roger

SHEPARD All systems go

The rising rocket was swallowed briefly by [illegible] cloud But you could hear its awesome roar and [illegible] was still climbing Every second that passed [illegible]

America's first ballistic rocket passenger toward a new frontier Cheers and claps rippled and erupted with each announcement of sustained success and life

SHEPARD O K It is a lot smoother now A lot smoother

No one knew at the time what he meant by the strange remark but he explained later he had encountered some unexpected capsule vibration during the climb — and deliberately had not reported it for fear someone on the ground would panic and press the button that would *touch off the emergency escape rockets*

Now we saw the rocket again thirty five miles above the earth high above the clouds growing perceptibly smaller as its speed passed 4000 miles per hour It appeared to be curving exactly as scheduled toward Grand Bahama Island

A O K reported Colonel Shorty Powers over the loudspeaker . Astronaut Shepard reports all systems A O K

Again a ripple of applause and cheers swept the ranks of observers A hundred things could still go wrong but the hazards of the launch were now safely behind us Now as Alan reported Five G cap sep [capsule separation] green the first of an intricate series of highly precise functions began First the mighty 78 000 pound thrust rocket engine shut down We could easily see the flame wink out 140 seconds after lift off Next the escape tower and escape rockets were jettisoned from the capsule Then three small posigrade rockets fired sepa

rating the capsule from the Redstone booster Alan was now alone in a tiny nine and-a half- by six-foot spacecraft hurtling out of our atmosphere All we could see from the ground far below was the condensation trail left by the rocket Up to this point Alan had been traveling for ward Now an automatic process — controlled by gyros — began to turn the entire spacecraft around so Alan would be facing the receding earth and the thick beryl lium heat shield would be facing the direction of flight This system changed the capsule s ' attitude by releasing a series of hydrogen peroxide gas pulses from tiny jets located at the neck and base of the capsule There was a separate jet system for yaw pitch and roll movements

When this delicate maneuver was completed a few seconds after cap sep, Alan reported calmly, "No movements' which meant that the gyros and gas jets of the automatic attitude control system had stabilized the capsule in its normal heat shield forward position Up to now Alan had not been "flying the spacecraft but rid ing merely as an observer Now, however, his gloved hands grasped two control grips beside his legs and he prepared to become the first man in history to fly a spacecraft (Yuri Gagarin s flight had been all automatic)

An aircraft, a submarine and a spacecraft have three possible variations in positions They can change direction up and down, that is change *pitch* They can change direction sideways, that is, change *yaw* And they can *roll* In the case of an aircraft or a submarine the direction changes could also change course, but since

Alan was on a ballistic trajectory any changes he made would change the capsule s position or attitude only and would have no effect on his course which had already been determined by the angle and speed of the rocket booster

Alan now performed all three of these changes or movements (actuated by jet pulses) as the following test pilot dialogue was exchanged by radio between Shepard and Slayton

SHEPARD O K Switching to manual pitch
SLAYTON Manual pitch
SHEPARD Pitch is O K Switching to manual yaw
SLAYTON I understand Manual yaw
SHEPARD Yaw is O K Switching to manual roll
SLAYTON Manual roll
SHEPARD Roll is O K
SLAYTON Roll O K Looks good here

Later on the motel lawn I asked astronaut John Glenn to explain to me just what Alan had done during these moments and this is how he answered He took over the capsule one axis at a time getting into it gradually He ended up with full manual control He controlled it at different altitudes controlled it throughout the retrofire maneuver which is the most critical of course and maintained the attitude of the capsule very well He went to the five degree positions that the capsule would go to as laid out

Thus did Alan Shepard s control of the capsule give America an important first in space flight But now he

had other functions to perform in the ~~few crowded min-~~ utes remaining

"On the periscope, reported Alan Then he allowed himself one of the few personal observations in his fact-packed report ' What a beautiful view!" he suddenly exclaimed as he caught his first view of the earth Down below there were murmurs of astonishment and awe that he could see all the way to Cape Hatteras, North Carolina near where *the Wright brothers first flew*

'Cloud cover over Florida, Alan reported, matter-of-factly, 'three- to four tenths in the eastern coast, obscured up through Hatteras Can see Okeechobee {Florida s largest lake], identified Andros Island [four hundred miles away in the Bahamas], identified the reefs"

He was now near the top of his flight, just over one hundred miles up, and he could see a section of the earth's surface more than eight hundred miles across He was now higher and moving faster than any other American in history

But it was time to leave the fascinating view of the earth and prepare Freedom 7 for reentry into our atmosphere Pointing straight forward at the center of the heat shield were three retro-rockets designed to slow an orbiting spacecraft They were not needed on a Redstone flight but they would be tested anyway to be sure they worked and didn't knock the capsule off its reentry attitude

This was another critical phase of the flight, because if the capsule did not return promptly to its reentry position after the three retro-rockets were fired one at a time

there was risk the capsule could burn up as it raced in the wrong position — for instance, sideways — through the hot friction of our atmosphere

Alan positioned the capsule with its blunt heat shield thirty five degrees above the horizon, then calmly reported back on the critical firing Retro one, very smooth retro two retro three All three retros are fixed '

On the ground there was a feeling of immense relief Now Alan still speaking confidently prepared for the last major hazard — reentry

O K , buster he shouted Reentry attitude ' The retro rocket package had by now been jettisoned or discarded and the protective heat shield was pointed straight toward the projected course of the spacecraft He began to encounter air friction roughly fifty miles up and cabin heat began to rise As heat and G forces built slowly upward, Alan's voice grew hoarse and guttural as he reported the G forces which mashed his body against the back of his contour couch

Four Gs he gasped then "six nine O K O K

To reassure him Deke Slayton told him Your impact will be right on the button

Alan continued to report Gs and altitude then announced that the six-foot wide drogue parachute had popped out as scheduled at twenty-one thousand feet and was slowing his telephone booth to a speed of approximately two hundred fifty miles per hour Then at ten thousand feet the huge sixty three foot main chute

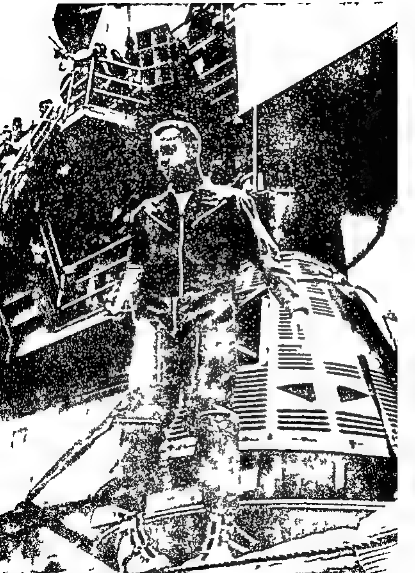
automatically unfurled and several other safety and position finding devices went into action Radar chaff, which resembles Christmas tinsel was scattered to aid radar tracking An explosive device called a sofar bomb was dropped When it hit the ocean it sank, as scheduled, and exploded at a depth of twenty five hundred feet, signaling its location to the special sonar equipment on nearby rescue ships A radio beacon on the capsule was also broadcasting

A few moments later Alan reported to his nearby rescuers ' Glad to be here aboard I am at seven thousand feet My position is good Everything A O K '

Back at Cape Canaveral we had lost radio contact just after Alan reached seven thousand feet All Shorty Powers could tell us was in his brief announcement at 7 47 "We expected it sooner, but communications with the pilot are getting a little rough' But we crowded around a tiny transistor radio that reported that Alan had been sighted by ship and helicopter Then to our own thankful satisfaction, Shorty announced impact at 9 50 and ten minutes later shouted "Freedom 7 is on the deck of the aircraft carrier!

Alan had made it and made it superbly

We learned later that three Marine helicopters were already orbiting around Freedom 7 as it drifted down precisely on target under its main chute The pilot had hooked on immediately allowed Alan two minutes to indicate whether he would ride to the carrier inside the capsule or inside the helicopter As he had intended all along Alan opened the side hatch (he could also have



Alan Shepard and Freedom 7 on board
the carrier *Champlain* after the flight

come out through the smaller opening in the top of the neck) and rode the twenty-five feet up to the helicopter in a sling A few minutes later, on deck of the carrier *Lake Champlain*, he was met by the cheers, the shouts the cameras and the waves of hundreds of proud and happy sailors Shortly thereafter President Kennedy called by radio telephone to congratulate him

America's first spaceman had performed flawlessly The costly one ton capsule had functioned with near perfection as it rose to a maximum height of one hundred fifteen miles then reached at a top speed of fifty-one hundred miles per hour to its impact point three hundred two miles downrange Each of the thousands of Americans who had been involved had done his job splendidly America had a new hero a new chapter in history, and a new claim on the limitless frontier of space

The first words Alan Shepard uttered when he returned from his brief trip into space were "Man what a ride! Nearly the whole world agreed with him — the missilemen at Canaveral officials in Washington his entire hometown of East Derry, New Hampshire as well as the press of the free world

Up in New England the normally reserved town of East Derry population six thousand expressed its pride and exuberance in countless ways including a hastily organized enthusiastic parade Cars carried placards WELCOME BACK, ALAN, FROM SPACE Bicycles were adorned with streamers The First Baptist Church of Derry rearranged its sermon bulletin board out front to read CON

GRATULATIONS ALAN SHEPARD GOD BLESS YOU Alan s proud parents and his sister told their happiness in a tele vision appearance with New Hampshire governor Wesley Powell Down in Virginia at Virginia Beach Alan's pretty brunette wife Louise flashed an elated smile as she told her neighbors ' It s wonderful' Just wonderful!"

Word arrived from London that millions of Europeans crowded around radio sets to follow the dramatic fifteen minute flight on a direct radio relay from Cape Canaveral In Japan radio and TV programs were interrupted to announce the events of the launch and recov ery Even the Russians sent congratulations but their reaction inevitably was tinged with propaganda compari son to Yuri Gagarin s orbital flight three weeks earlier There was sincere praise, however from most Soviet sci entists

But perhaps the most thankful reaction of all came from the missilemen and science writers at Cape Canav-eral who fully knew what the hazards were — especially the hazard of conducting such a delicate exploit in the merciless glare of full publicity Said *Miami News* editor Bill Baggs ' The difference between this shot and the Russian shot is that we called ours sort of like Freedom 7 in the Grand Bahama pocket '

We learned from people who had watched the shot from the beach where thousands had lined up along the seven mile stretch that a number of persons had fol lowed the flight with surprising emotion One gray haired woman with tear streaked cheeks was not apolo gizing for being on her knees during the shot I ve seen

Astronauts Slayton (*far left*) and Grissom (*far right*) greet Alan Shepard at Grand Bahama Island

lots of shots' she said but this one was different I prayed all the way' At another place on the beach a young woman had been seen explaining to an aged blind woman standing beside her what the launch looked like

Canaveral missilemen were glad to share with the world the matchless drama as well as the fearsome risks of a major rocket launch and they were pleased that their gratitude to Alan Shepard the first space-flying as-

tronaut in Project Mercury, had swelled to become the gratitude of all

Four days after his flight, after he had rested in the Bahamas Alan Shepard flew to Andrews Air Force Base for an official Washington welcome Three helicopters whisked Alan and the other astronauts to the White House lawn After a brief chat President Kennedy led the astronauts to the White House rose garden where he presented Alan with the NASA Distinguished Service Medal 'for outstanding contributions to space technology' President Kennedy accidentally dropped the medal and as he picked it up, he smilingly told Alan This medal comes to you from the ground up' Then after Mrs Kennedy reminded him the President pinned the medal on Alan s coat

Later, as NASA s eight car motorcade paraded down Pennsylvania Avenue 250 000 persons cheered and hailed the astronauts and Alan Shepard At the subsequent press conference in the State Department auditorium Alan reaffirmed that he had encountered no difficulty during his five minute period of weightlessness In fact he called the period of weightlessness a pleasant sensation He also pointed out that it was readily possible for a man in a spacecraft to exercise control of the vehicle not only in actual space flight but in the critical period of reentry into the earth s atmosphere

There were no bad moments Alan said in Washington but one month later NASA reported that Alan s vision became blurred one minute and twenty four seconds after lift off The blurring came during maximum

vibrations in early flight as transonic speed approached maximum aerodynamic pressure 'At one point," reported Alan "my head vibration was such that my vision was blurred for a few seconds' But he indicated he could still read his instrument panel Thus the one unexpected difficulty of the flight was a fairly minor matter that could easily be corrected by adding more foam rubber to the astronaut s head support

The sum total of Alan's flight added up to a firm plus factor for the step by step exploration of space Alan s personal performance and the performance of the complicated booster and spacecraft equipment had one vitally gratifying thing in common — both worked to a degree of perfection that is rare in the pioneering attempt to invade any new frontier For once the capricious law of averages that had characterized all our urgent efforts to conquer the space frontier worked magnificently in our favor

11

Gus Grissom in Liberty Bell 7

DURING THE SPRING of 1961, while waiting for the second manned suborbital flight from Cape Canaveral, with Virgil (Gus) Grissom as pilot, I visited the factory at McDonnell Aircraft Corporation in St Louis to see how the Project Mercury spacecraft were built

Hundreds of United States companies — and thousands of persons — were involved in the construction of the amazing spacecraft but McDonnell Aircraft — a youngster among American aircraft manufacturers — was the prime capsule manufacturer The job of designing and building such an intricate outer space vehicle was a completely new adventure for American scientists and technicians The undertaking also involved unprecedented hazards Parts and components were manufactured by over four thousand suppliers and vendors all over the United States but McDonnell had the primary responsibility for the basic concept and for assembly

The original challenge was an astounding one design a device that would keep a man alive that could withstand both the extreme subzero cold of high altitude and the

blazing heat (up to 600 degrees Fahrenheit) of reentry, that could be controlled in the near vacuum of space where wings and the aircraft type of control surfaces would be useless, that could be blasted away from its booster in case of an accident on or near the ground, that could be safely separated from its booster at high altitude, that could automatically turn itself around in mid-flight that could be slowed down at any desired point of orbital flight so it could return to earth, that would automatically and at a precise altitude eject a stabilization (drogue) parachute and a main parachute, that would not break apart when it finally struck either land or water that would float without leaking, that could carry a life raft that could be lifted and transported by a helicopter, that could carry enough oxygen for twenty-eight hours that would enable an astronaut to see outside, that would automatically monitor or watch all its systems and functions and constantly radio condition and status to earth, that would, in fact, do all this by not just one means or method, but — for safety reasons — by alternate or backup means known in the missile business as 'redundancy ' And perhaps the most restrictive qualification of all the final spacecraft with all its gadgets and components and instruments crammed into it could not weigh — counting the astronaut s weight and his thirty pound space suit — more than one ton This meant that all metals had to be not only strong but extremely light All instruments and mechanisms had to be not only efficient and 100 per cent reliable, they had to be miniaturized to an unheard of degree If the weight limit was ex-

ceeded existing U S booster rockets could not get the spacecraft up to the necessary speed and altitude

Early in 1958 McDonnell turned over the complicated design problem to a group of twelve engineers For ten months these engineers and the twenty eight engineers and technicians assigned to help them sweated over their unique challenge Every decision they made brought them squarely against an awesome proposition *Will it keep an astronaut alive?*

To allow for metal expansion during the red hot reentry phase the engineers decided to make the outer sides of the spacecraft of a nickel cobalt alloy, thinner than a dime but corrugated for added strength To protect the particularly sensitive forward end of the capsule from the deadly fire of atmospheric friction heat they decided, first of all to build the largest piece of beryllium ever forged — a six foot disc known as a heat shield to be used for the suborbital flights only An even tougher resin and glass fiber heat shield using the ablation principle, was designed to protect the astronaut during reentry from orbit (This shield by ablating or boiling on its outer surface would allow most of the heat to dissipate This is the same principle which prevents the temperature of boiling water from rising above a certain point no matter how much heat is applied to the water) To further protect the astronaut from cold heat and vacuum the engineers designed an inner shell of lightweight titanium separated from the nickel cobalt by an inch and an half of insulation

To provide redundancy for control of the spacecraft's attitude, three separate control devices were designed, ranging from fully automatic to manual To be sure all these delicate systems were manufactured under the best and most rigid conditions possible, special environmental control and quality control engineers laid out a large superclean "white room' When I inspected this clinically clean room in St Louis, I saw a row of five capsules mounted on white construction rigs Spacecraft technicians wore white caps and white smocks or coveralls

The room was absolutely spotless There were none of the grease and debris usually associated with manufacturing Despite the fact that the air in the room was filtered to prevent dust and rust, two technicians were busy vacuuming one of the spacecraft with a flexible hose Even the smallest amount of dust or metal scraps might foul the capsule s mechanisms With seven miles of wire in each vehicle, you would expect to find scattered about small bits of insulation or wire so common in electrical work None was visible anywhere

These technicians had already discovered the hard way that even superhuman efforts at cleanliness inside a superclean room were not 100 per cent perfect On an earlier unmanned flight from Cape Canaveral, cameras had recorded small bits of debris floating around the cockpit and Alan Shepard in his flight of May 5 had reported dust in the cockpit during the period of weightlessness when tiny particles floated out from inaccessible places One technician told me he was determined this

was not to happen again It was obviously a matter of pride with him that he was responsible for eliminating every speck of cockpit dust

I asked to see the capsule that would carry Gus Grissom into space and was told that it had already been transported to the Cape in a sterile plastic container There, in another clean room, another group of McDonnell engineers a portion of the four hundred McDonnell people at Canaveral put it through additional check outs and modifications (In all, NASA had ordered twenty spacecraft from McDonnell The first sixteen were for suborbital flights and for unmanned orbital flights The remaining four were all in the process of being modified with additional oxygen hydrogen peroxide and other facilities for eighteen orbit missions)

But spacecraft generally similar to Gus Grissom's were available for inspection At first as one looks inside the tiny jammed cockpit which is smaller than that of a fighter plane the overwhelming impression is of an electronic jungle With the help of an informed guide however some of the complexity begins to break down into understandable units The pilot s seat, or contour couch is the focal point because all instruments and controls are oriented toward it Beside the pilot s knee position on either side are the control levers The one on the left is called an abort handle or more commonly the 'chicken switch The pilot activates it if he wants the escape rockets to go off On the right is the sidearm controller which controls the capsule s attitude by activating small hydrogen peroxide jets clustered on the sides and at each

end of the spacecraft The sidearm controller works somewhat like the stick on an airplane If you push it forward or backward you change the pitch, or up and down motion If you twist it you yaw to the right or left, and if you move it right or left, you roll The more force you apply to the controller, the faster the response In simulation flight trainers, which McDonnell also built, the astronauts had learned to use the controller with the skilled delicacy of a steam shovel operator picking up an egg

In front of the spaceman — just a few inches above his face level, in fact — is the crowded instrument panel It looks complicated but it is actually simpler than that on a jet plane, chiefly because the capsule, of course, has no engine Its momentum and basic course are both supplied by the monstrous booster which drops away in early flight At the left side of the instrument board there is a panel of mode selector switches (for the method the pilot wishes to use on attitude control), switches for cabin lights for use when traveling on the dark side of the earth, and miscellaneous light and other switches Just to the right of this panel is a vertical row of labeled signal lights to enable the astronaut to keep track of the various events and processes of his mission — such signals as when the escape tower is jettisoned when the retro-rockets fire, and when the drogue and main chute are released When these events properly take place, the signal turns green In the center, directly in front of the pilot s face, are his flight instruments (which tell him how fast and in what direction he is pitching yawing or rolling),

an earth path indicator that shows exactly where he is in relation to a small colored earth globe, a round periscope screen through which he gets a direct picture of the earth below him plus assorted instruments and timing devices On the right side of the board are the dials and switches that control conditions within the capsule such as pressure oxygen supply, temperature and battery output

Altogether, if an astronaut swept his eyes over his main instrument panel he could register 136 separate bits of information which is not an unusual requirement for a trained test pilot If you allow for the fact that he is essentially keeping track of the planned flight events which he can partially anticipate and is primarily monitoring or scanning his instruments constantly for a 'go or no go' condition of various systems then his job is not so enormous that he can t occasionally as Alan Shepard did look out at the world and exclaim What a beautiful view!

Each of the astronauts had in addition to his general all round training, a particular specialty The cockpit layout specialty fell to John Glenn and it is a tribute to his constant evaluation as a trained test pilot and to the industry and imagination of McDonnell designers that the Shepard flight had gone so extraordinarily well

As I watched the white suited spacecraft technicians go about their tasks with the skill and grace of master mechanics they seemed to have a proprietary interest in their spacecraft They knew there were over ten thousand parts in that tiny precision built spacecraft and that

nearly every one had to work flawlessly to bring Gus Grissom back alive

America's second space pilot was the smallest and one of the quietest of the original seven astronauts Air Force Captain Virgil Ivan (Gus) Grissom thirty-six, had a small wiry 150-pound frame, stood five feet seven inches tall, and customarily answered all questions briskly and briefly

'There is nothing put on or showy about Gus,' said one of his close friends He s a guy who'll never volunteer his feelings unless he s asked — and even then it's like pulling teeth' "I m a test pilot, not a philosopher Gus once said 'I m too busy to worry or philosophize about things This is a day to-day job with me'

Gus was a veteran pilot, sharing with astronaut Don Slayton the most jet time of any of the astronauts 2540 hours In Korea he flew one hundred missions in the famed F 86 Sabrejet, earned the Distinguished Flying Cross and Air Medal with Oak Leaf Cluster His only flying accident occurred when he and astronaut Gordon Cooper were taking off in a two-seater T-33 jet trainer The landing gear buckled as the plane skidded and caught fire, fortunately neither astronaut was hurt This happened before either of them was selected as an astronaut Gus was married when he was still nineteen to his wife Betty They had two sons, Scott and Mark

Gus Grissom liked to emphasize the team effort of America's manned space flights In his typically modest

fashion he once said "The glory of being first is not everything" It had fallen to Commander Alan Shepard to be the first American in space Then Gus Grissom had functioned in a secondary supporting role Now, in July 1961 it was Gus s turn to assume the role of star performer, to cut loose the shackles of earth and explore in his own fashion the world of space and the world of personal hazard where an astronaut like a bull fighter, lives with cool grace within inches of death

When the members of the free world press NASA officials manufacturers, and officers of the armed services again converged on Cocoa Beach s motel row in mid July, the general word was one of cautious optimism Everyone of course, was pulling for Gus Grissom but haunting the minds of most observers was the ever present possibility of failure in the missile business Said Lieutenant Colonel John (Shorty) Powers just before the flight, "The fact that we sent Shepard on that flight and it was perfect is no guarantee that this one will be the same There is always a risk element involved We are not pacing the floor with furrowed brows but we are concerned that we will have less than the perfect flight of Freedom 7" Shorty s comments were grimly prophetic

The Liberty Bell 7 capsule was basically similar to Alan Shepard s — as was the suborbital mission itself — but there were important differences in the two spacecraft The side escape hatch for instance on Freedom 7 was operated mechanically To save weight on Liberty Bell 7 the mechanical means of opening the hatch had

been replaced by a new system designed to blow the hatch off with explosive bolts Alan Shepard had used two small round ports for outside observation Gus Grissom s capsule had been made, partly at Alan's suggestion, with two 'picture windows nineteen inches high for better visibility There were other minor changes in the azimuth, or capsule angle, during orbit and in the attitude control system itself

As shoot day approached, the local Cape Canaveral weather, as usual, was not cooperating In addition, the first hurricane of the season Anna, was disturbing surface conditions just south of the planned impact area On Wednesday, July 19, Gus Grissom repeated Alan Shepard s frustrating experience of dressing, boarding the capsule, then being held there rooted to the ground because of local cloud cover The clouds were at fifteen thousand feet — just the altitude at which engineers particularly wanted a film record of the flight It was in this area that Alan Shepard had reported vibration Engineers therefore had beefed up MR-4 with a new clamp ring fairing, and they wanted a film record from a camera plane to see how effectively the new device reduced vibration During the agonizing wait Gus repeated to Mercury Control that he was ready to go 'I ve flown through clouds before, he complained at one point But the clouds hung on and operations director Walter Williams was forced to scrub the flight Gus Grissom, like Alan Shepard before him now had to take the long ride back to his double deck bunk in hangar S along with his roommate and backup man John Glenn

Friday morning, at 1 10 A M , Dr William Douglas again awakened the two astronauts Weather was still marginal but Walter Williams had decided to try again Gus and John ate a breakfast of steak and eggs Then Gus repeated the physical exam and the meticulous suit ing up procedure and at 3 55 A M , about two hours before dawn, entered the Liberty Bell 7 spacecraft atop the fifty eight foot Redstone Looming out over the ocean was a threatening bank of dark clouds but a few stars were visible directly above the launch pad

The countdown progressed steadily right on schedule as if the rehearsal of two days ago had ironed out all the frustrations The first hold came at 5 15, but the count re sumed after a brief interval As the light brightened, the few holes in the overhead clouds gradually enlarged Fi nally the sun showed around a pink ocean thunderhead and glinted off the windows of the "greenhouse sur rounding the spacecraft At 5 50 the gantry rolled on its great tracks away from the rocket There were other mi nor holds then at 7 05 at T minus 15 minutes astronaut Gordon Cooper roared to a takeoff down Cape 'skid strip ' He was flying an F-106 jet to observe the early flight of the rocket A few moments later a reporter squinted up at the thinning clouds and said 'Yeah they re gonna fling him' Now the sun brightened the black snouts of the ranks of TV cameras all aimed at the loxing rocket A still air of expectancy hung over the knots of silent newsmen

During the last tense seconds Gus Grissom — who had already talked to his wife Betty in Newport News

Virginia directly from Liberty Bell 7 — was in constant voice communication with Alan Shepard and Deke Slayton Their dialogue was informal, terse and effective as the moment of launch approached

SLAYTON No sun in your eyes?
GRISSOM No sun in my eyes
SLAYTON O K coming on T minus one minute Have a good trip bub We'll see you below Firing command in thirty seconds

This was the moment of supreme challenge Every pilot has felt it at one time or another Matadors have felt it Mountain climbers have felt it So have skin divers in the cold ocean's depths Now Gus Grissom, of Mitchell, Indiana, was feeling it as his pulse raced at 170 beats per minute on a scarred piece of flatland at Cape Canaveral

"MAIN STAGE! LIFT OFF!"

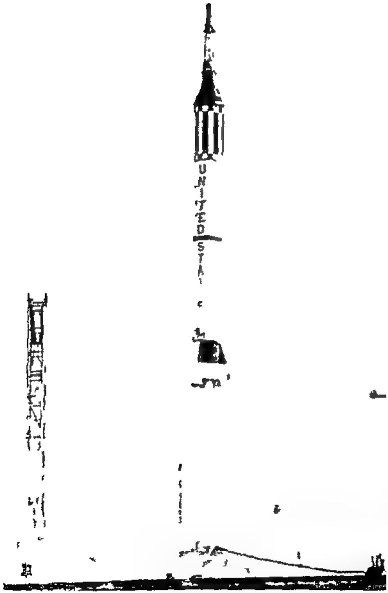
An explosion of smoke A flash of flame And gravity was overcome as Redstone began a rise and a climb and a voyage that was as old and as new as the questing spirit of man The rocket rose on its tail of scorching fire

'Roger' said Gus Grissom This is Liberty Bell 7 The clock is operating

"Loud and clear," responded Shepard 'Jose don t cry much! (Shepard with a jest was referring to a recording about a comic named Jose)

"Okey doke," said Grissom 'It's a nice ride up to now'

The rocket pushed upward, a flame tipped pencil climbing in early morning light



Mercury Redstone 4 blasts off
with Virgil Grissom in the capsule

GRISSOM Looks good here We are starting to pick up a little bit of noise in the vibration Not bad though at all O K , the fuel is go One and a half Gs Cabin is eight and oxygen is go with twenty-seven amps

SHEPARD Pitch is seventy seven Trajectory is go

Still climbing Watching newsmen cheered

GRISSOM I could feel the hand controller move just a hair there The cabin pressure is holding Oxygen is go at twenty five amps

SHEPARD Stand by for cutoff

GRISSOM I see a star [He had bet Alan a steak dinner that he would see a star] There went the tower Green on the tower [The escape tower has been jettisoned]

SHEPARD Roger Turnaround is started

GRISSOM We are at zero G and turning around and the sun is really bright Oh boy Manual handle is out The sky is very black

SHEPARD Read you loud and clear Gus

GRISSOM There is a lot of stuff floating around up here [He's weightless The ' stuff is dust, one small washer, debris, etc] I am trying a yaw maneuver I am on the window It is such a fascinating view out of the window you can t help but look out that way

SHEPARD I understand T plus thirty, Gus

GRISSOM I can see the coast but I can t identify anything About all I can really see is clouds

By now the rocket and the capsule were invisible from the earth Grissom s voice was a voice from beyond the atmosphere

GRISSOM I am not in very good shape here [Meaning his retro attitude was not quite the way he wanted it]

SHEPARD Got fifteen seconds to retros Plenty of time

GRISSOM O K , there s one firing There ■ two firing Nice little boost There went three

SHEPARD Roger All retros are fired [Retros were not necessary on this flight They were being tested for orbital flights to follow]

GRISSOM O K yeh they fired out right there The retros have jettisoned Now I can see the Cape and, oh boy that s some sight

SHEPARD Roger Retros have jettisoned Scope has retracted You re going to reentry attitude

GRISSOM Affirmative

SHEPARD How does it look out the window now?

GRISSOM The sun is coming in and all I can really see is just oh just darkness The sky is very black

SHEPARD Roger You have some more time to look if you like

The flight was now half completed The altitude was a new record for an American just topping Shepard s 115 mile height

SHEPARD Bell 7 from cap com How do you feel up there?

GRISSOM I feel very good Everything is very good I've got five hundredths Gs [light] and the roll rate has started

SHEPARD Roger

GRISSOM Got a pitch rate in here O K Gs are starting to build Gs are building We re up to six Gs There s nine Gs

SHEPARD Roger, still sound good

GRISSOM Here s about ten Gs O K The altimeter ■ still active at sixty-five [thousand feet] There s sixty [thousand feet] O K I m getting some contrails, evidently shock wave [One of the recovery pilots reported later seeing these contrails for quite a long time] Fifty thousand feet I m very good Everything is fine

Elapsed time since launch was 8 minutes 42 seconds Gus Grissom was approaching the point the parachutes were supposed to go out The first braking or drogue chute deployed at T plus 9 minutes 41 seconds

GRISSOM There's the drogue chute The periscope has extended

SHEPARD We have a green drogue light here

GRISSOM [at T plus 10 minutes 14 seconds altitude 11 000 feet] There goes the main chute, it s reefed The main chute is good The rate of descent is coming down to — there s forty feet per second thirty two feet per second on the main chute and the landing bag is out green

At this point a strange voice entered the transmission No one knows where the voice originated The voice said clearly Ah it s better than it was Chuck

Now at around T plus 11 the Atlantic ship capsule communication joined the transmission

ATS Bell 7 read you loud and clear Your status looks good Your systems look good We confirm your events

GRISSOM I'm in the process of putting the pins back in the door at this time I m passing down through six thousand feet Everything is good ah I m going to open my face plate *Hello I can't get one I can t get one* door pin back in I ve tried and tried and can t get it back in And I m coming ATS I m passing through five thousand feet and I don t think I have one of the door pins in [The door pins enable small wires to keep the hatch from shooting off its full twenty five foot range which would endanger recovery personnel The reason Gus stressed this was to warn them to stay clear of the door after he landed]

ATS Roger Bell 7 Roger

GRISSOM Do you have any word from the recovery troops?

Now the radio relay plane which relays communications to Mercury Control came on the air under the code name of Card File

CARD FILE Liberty Bell 7, this is Card File 23 We are heading directly toward you

ATS Bell 7, do you have any transmission to MCC [Mercury Control Center]? Over

GRISSOM Ah, Roger, you might make a note that there is one small hole in my chute It looks like it is about six inches by six inches I'm passing through three thousand feet two thousand feet Can see water coming right on up

Now the rescue helicopters code named Hunt Club, made their first contact with Liberty Bell 7

HUNT CLUB Liberty Bell 7 Hunt Club is now two miles southwest of you

At 15 minutes 37 seconds after launch, Liberty Bell 7 hit the sea, one of the oldest friends and enemies of man The mission so far was a success

When Liberty Bell 7 struck the water, America's second astronaut later described the sensation as a mild jolt not hard enough to cause discomfort or disorientation' Explained Grissom 'The spacecraft recovery section went under water and I had the feeling that I was on my left side and slightly head down The window was covered completely with water and there was a disconcerting gurgling noise A quick check showed no water entering the spacecraft The spacecraft started to slowly right itself as soon as I was sure the recovery section was out of the water, I ejected the reserve parachute

The spacecraft then righted itself rapidly I felt I was in good condition at this point and started to prepare myself for egress'

His face plate was already open Next, he disconnected the oxygen outlet hole at the helmet, unfastened the helmet released the chest straps the lap belt, the shoulder harness and the knee straps He then disconnected the five sensors which joined his body to the capsule s radio transmitters He now adjusted a rubber diaphragm known as a neck dam around his neck as a precaution to keep his suit from taking in water This left him connected to the spacecraft in only two places the oxygen hose which entered the abdomen area of the suit to cool it, and the wires leading to his helmet earphones and mikes

"I now turned my attention to the door [hatch] Gus Grissom reported later "First, I released the restraining wires at both ends and tossed them toward my feet Then I removed the knife from the door and placed it in the survival pack The next task was to remove the cover and safety pin from the hatch I felt at this time that everything had gone nearly perfectly and that I could go ahead and mark the switch position chart as had been requested

At this point Grissom made the following transmission to Hunt Club 1 Give me about another five minutes here to mark these switch positions here [the switches on his instrument panel] before I give you a call to come in and hook on'

Hunt Club 1 replied, 'Roger, we are ready any time you are '

About four minutes later Grissom said, 'O K Latch on, then give me a call and I'll power down cut [the capsule's battery power off] and blow the hatch O K?

I've unplugged my suit so I'm kinda warm now

Hunt Club replied 'Roger, and when you blow the hatch the collar will already be down there waiting for you and we re tuning base at this time

The last radio communication between them was Gus s answering "Roger

He was waiting for the helicopter to lift the capsule partially out of the water so he could blow the hatch above the wave level Here is how Gus later described in his official flight report the accident that happened next

'I was lying on the couch waiting for the helicopter s call to blow the hatch I was lying flat on my back at this time and turned my attention to the knife in the survival pack, wondering if there might be some way I could carry it out with me as a souvenir I heard the hatch blow — the noise was a dull thud — and looked up to see blue sky out of the hatch and water start to spill over the door sill Just a few minutes before, I had gone over egress procedures in my mind and I reacted instinctively I lifted the helmet from my head and dropped it, reached for the right side of the instrument panel and pulled myself through the hatch

"After I was in the water and away from the spacecraft I noticed a line from the dye marker can over my

shoulder The spacecraft was obviously sinking and I was concerned that I might be pulled down with it I freed myself from the line and noticed that I was floating with my shoulders above water'

By now the first helicopter was on top of the spacecraft and had cut the projecting antenna in record time and had hooked on But the spacecraft with its heavy load of water was already sinking The engines of the first helicopter had already heated up badly and all three wheels were touching the water The helicopter pilot, Captain Phillips Upschulte of Quincy, Illinois was having a rough time of it with the overloaded capsule

Gus Grissom s ordeal was even worse In the excitement he had forgotten to lock the oxygen inlet port at the midsection portion of his suit and air was rapidly seeping out the open port and out the neck dam His heavy suit was filling up and he was sinking deeper and swallowing water A second helicopter piloted by Lieutenant John R Reinhard of Bloomington Illinois, had a sling lowered for Gus nearby but, said Gus 'I apparently got caught in the rotowash between the two helicopters because I could not get close to the second helicopter even though I could see the copilot in the door with a horsecollar swinging in the water

For several desperate minutes Gus Grissom was in serious danger as he frantically struggled to stay afloat and to reach the horsecollar which was his only link to safety The second helicopter couldn t approach him for fear of striking the rotor blades of the first helicopter, which was still attached to the spacecraft Said Gus "I

was going under water quite often The mild swells we were having were breaking water over my head and I was swallowing some saltwater"

Meanwhile Captain Upschulte realizing he could not salvage the sinking one million dollar spacecraft with its valuable store of film and electronic records of the flight gave the difficult order to cut the cable Even as Gus struggled, sinking deeper in the water, he realized Liberty Bell 7 was lost forever in 2800 fathoms (about three miles) of water

Back at Cape Canaveral, where word of Gus's difficulty was relayed to Mercury Control Alan Shepard recalled that 'Gus was a good floater,' remembering that in their extensive water training exercises Gus Grissom had an unusual body buoyancy

He needed every ounce of buoyancy he had When he finally reached the horsecollar, he was so desperate to get out of the water that he put it around his armpits hastily and backwards Nevertheless he gave the thumbs up signal to hoist away Once he was inside the helicopter crew was surprised to see him immediately grab a life preserver

My first thought was to get on a life preserver he said later so that if anything happened to the helicopter I wouldn t have another ordeal in the water'

But Gus Grissom s ordeal was over Nineteen minutes after Liberty Bell 7 struck the water he stepped out of the rescuing helicopter, grim-faced and sober aboard the aircraft carrier *Randolph* The first thing he asked for was a glass of water

Except for the loss of the valuable spacecraft — a loss

later officially attributed to the accidental discharge of the explosive bolts in the hatch before the helicopter had lifted the hatch fully above the waterline — the flight of Liberty Bell 7 was of course, a success Gus had reached a maximum altitude or apogee of 118 miles (compared to 115 miles on the Shepard shot) and had impacted 303 miles downrange (Shepard went 302 miles) Nevertheless in such a complicated vehicle there were numerous small things that functioned less than perfectly Gus thought that the trouble he was having with attitude control might have been due to a sticky valve in one of the roll jets He was also concerned about the possibility of an astronaut s vision becoming extremely impaired if the very bright shaft of space sunlight he referred to should actually fall across his helmet visor Since this could be a serious problem for an astronaut strapped on his back in a fixed capsule attitude consideration was given to installing some sort of adjustable visor or shade, either on the window or the helmet At one point when he was preparing to leave the spacecraft, Gus reported later two of his straps had become tangled across his shoulder He thought the strap system might need revision to avoid possibly entangling an astronaut who had to get out in a hurry to save his life

But considering the nature of the mission it was gratifying that so little had gone wrong After Gus Grissom became adjusted to the immediate disappointment of the loss of Liberty Bell 7, including the knife he had wanted to keep as a souvenir, he was flown to Grand Bahama Island where he was enthusiastically greeted by astro

nauts John Glenn and Wally Schirra and NASA administrative director James E. Webb Also on hand was Dr William Douglas, who reported Gus in "tiptop shape," except for slight fatigue due primarlily to his struggle in the water At his first free moment Gus called his wife Betty in Newport News, Virginia, and arranged to meet her and the children at Cape Canaveral, where his press conference was scheduled after his rest period was over Wally Schirra summarized the feelings of many people when he told the dedicated helicopter pilots "We're glad you got Gus back We can make new capsules

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John Glenn's Glory Ride

AFTER the near tragedy of Gus Grissom's flight of July 21, 1961, the score of United States and Russian manned space flights stood at two brief suborbital flights for the United States and one full orbital flight (Yuri Gagarin) for the Russians. Few serious observers felt that the two countries were then even in their manned flights, primarily because orbital flight is so much more difficult and represents such a tremendous step forward in the state of the art of rocketry. Russian scientists tended to scoff at the short ballistic flights of the United States, just as earlier they had scoffed at our small satellite which Khrushchev had once called "grapefruit." Nevertheless, as far as satellites were concerned, the United States was well ahead in every area except weight of individual satellites. Russian priority in weight was due, of course, to their superiority in booster thrust, which they had maintained from the beginning. The United States had launched a total of forty-six earth satellites, twenty-seven were still in orbit and eleven of these were still transmitting valuable scientific information. The Russians had launched

fourteen earth satellites, one was still in orbit, none was transmitting The United States had recovered six spacecraft from orbit, the Russians, four The United States had not hit the moon (we had never actually tried to hit the moon, we had tried and failed five times to reach the moon's vicinity), the Russians had hit the moon once

In July 1961 there were three major mysteries about Russian rocketry First, why had they not followed up their initial unmanned satellite flights with many more launches designed, as our flights were, to increase the store of scientific information? Second, what was the truth behind persistent reports coming out of Russia that they had already lost men in space flights? And third why had they not followed up their launch of Yuri Gagarin into a single orbit with a longer flight of another cosmonaut?

The word at Cape Canaveral and Washington — open to anyone — was that we were proceeding with preparations for a manned orbit attempt — probably three orbits — late in 1961 or early in 1962 NASA would not confirm it officially, but most of us felt certain that popular John Glenn, the backup astronaut on our first two flights would be the selected astronaut

Dramatically and suddenly as was Russia's fashion the USSR solved one of the mysteries On August 6 Radio Moscow announced that a twenty six-year-old Russian major named Herman Stepanovich Titov was now in his second orbit around the earth following a 9 A M launch Sunday morning Moscow time Orbit time was 88 6 minutes His speed was 17 750 miles per hour

There were unconfirmed reports that Titov would remain in orbit for an astonishing seventeen times around the earth and that his spaceship Vostok II would be brought to a landing on Monday As his status reports flooded in it was apparent that another great milestone in man s conquest of space had been reached

Amid widespread disappointment that the United States had not been able to accomplish multiple orbits first there was general astonishment at the Russian feat Each announcement was another triumph on the space frontier On his second pass over Africa Titov sent a good will message to the African people and as he subsequently passed over Russia he exchanged messages with Khrushchev At 11 48 A M he entered his third orbit and sent a message to Europe At 12 30 he ate a three course half hour lunch and at 5 30 he ate another Incredibly — because he must have fully trusted his spaceship — he announced at 6 30 over Russia Good night I am going to bed Then he wisecracked I wish you had it so good All goes excellently I want to wish you dear Muscovites good night Now I am going to bed You do what you want but I am going to bed After his eight hour sleep he had traveled a distance greater than that from the earth to the moon (238 840 miles) Most important of all — from the standpoint of man s ability to survive extended weightlessness — he radioed at 3 A M Monday morning that he was feeling well after twelve spins around the earth and eighteen hours in space Despite another series of highly speculative newspaper stories that the Russians were faking their space flights

there was actually no doubt he was up there His voice was clearly picked up in Chicago and elsewhere around the world, and Vostok II was sighted by thousands of people in Charleston, South Carolina, for about thirty minutes

This was already an accomplishment to compare with that of Ferdinand Magellan's crew who circumnavigated the globe in 1519 or with Columbus's voyage to the West Indies in 1492

On Monday, the United States learned that Russia had succeeded in landing the 10,430 pound (about five tons) spacecraft after seventeen orbits, which kept Herman Titov in space more than twenty four hours The landing area was near Saratov, about 440 miles southeast of Moscow His maximum height, or apogee was 159 5 miles The low point of the orbit, or perigee was 110 5 miles While in flight he had eaten heartily several times slept well — in fact thirty seven minutes longer than he intended — had done setting up exercises in the roomy spacecraft and had maneuvered the craft by manual controls as Alan Shepard and Gus Grissom did From all reports available at that time his condition was excellent

Herman Titov, who referred to himself while in flight as 'the eagle, had demonstrated that man could survive prolonged weightlessness and perhaps even more important at this point he could survive cosmic rays Even though he was flying well below the bands of radiation discovered by Dr James Van Allen of the University of Iowa there was the strong possibility that he could be affected by the bombardment of atomic particles In

some of our own experiments in sending black mice to high altitudes in balloons, some of the mice had returned with white patches in their black coats where they had been struck by cosmic particles But, according to the first Russian announcements, Titov had suffered no ill effects whatsoever It was only later that U S scientists learned that Titov had become mysteriously ill after his first six orbits We didn t know how sick — or whether his reported nausea was individual to Titov or universal in the weightless state — but we had enough faith in his reported illness in space to plan special exercises of our own to test the ability of the human body to remain in normal condition

As Moscow prepared a gigantic welcome for the Rus sian eagle,' who was born in the tiny Siberian village of Verkhyeye Zhilinio Yuri Gagarin raced home from his Canadian visit to be on hand for the celebration Also converging on Moscow were Titov s father a retired schoolteacher and Titov s wife Tamara twenty four who had exhausted herself following the entire flight on the radio

As the Moscow celebration hailed Major Titov (he had been promoted in flight from captain) U S scientists and astronauts proceeded determinedly to seek out the an swers we needed for ourselves We learned from the Gagarin and Titov flights only the barest details the Russians released largely for propaganda purposes Their actions contrasted markedly with that of the United States which published the complete and detailed scientific find

ings of both the Shepard and Grissom flights These reports were available to the entire world

The mission of Project Mercury remained essentially the same We proceeded with our scheduled flights leading step by step to the launch of a man in orbit We were making our own way cautiously and, so far, safely toward the beckoning space frontier

A month after Titov's flight — on September 13 — we launched into orbit from Cape Canaveral a talking breathtaking" mechanical man — sometimes called a "canned man" or ' crewman simulator ' The canned man was not a robot in the usual sense rather, it was a series of mechanical and electronic devices contained in a box three feet tall two feet wide and one foot thick The box was designed to duplicate the respiratory functions of man as nearly as possible by removing oxygen from the cabin environment and adding carbon dioxide The box also added water vapor in proportions approximating that of human breath

The booster rocket was the same one that would attempt to blast our next astronaut into orbit — the mighty 360 000 pound thrust, eighty-nine-foot Atlas This was more than one and a half times the power of the Redstone rocket that had launched Shepard and Grissom The spacecraft successfully completed one orbit, as was scheduled, and was recovered by the destroyer *Decatur* thirty nine miles from its intended point of impact near Bermuda But the mechanical man suffered a

loss of oxygen when the system unexpectedly sprang a leak (If a live man had been aboard, however, he could have turned on the reserve oxygen supply) Also the tape recorded voice of the canned man designed to communicate with ground stations was lost as the spacecraft orbited over Australia Another minor failure was the malfunction of an inverter which supplied power to a fan that circulated air but fortunately a backup inverter automatically took over as a substitute This was the first time in ten Mercury test flights that any one of the numerous backup devices had actually been employed

Officials were generally pleased with the shoot, but the unexpected minor malfunctions probably meant the attempt to orbit an astronaut would have to be postponed beyond 1961 Said NASA operations director Walter Williams We re still trying hard to orbit an astronaut this year, but I think first we ll have to give this another go with an unmanned capsule or with an animal

The next attempt to fire living matter into space two months later (November 10), resulted in a spectacular tragedy — not for a man but for a one and a half-pound squirrel monkey named Goliath The rocket booster was an advanced Atlas E model not the more thoroughly flight tested Atlas D which was planned for American astronauts Goliath was intended to be a passenger on a five thousand mile ballistics flight downrange Fifteen seconds after launch one of the three Atlas engines unexpectedly shut down, the other two engines were unable to maintain course Thirty seconds after launch the range safety officer pressed a destruct button on his console

that blasted Atlas into a tremendous inferno of fire that probably killed Goliath instantly (There was no automatic escape device on this shot No Project Mercury spacecraft was attached, the monkey rode inside a nose cone at the top of the rocket) Goliath thus became the twenty-ninth known rocket borne animal of the United States and Russia to be sacrificed to the cause of space flight

Even though the faulty Atlas was not the model intended for John Glenn, the spectacular explosion—which actually rained flaming chunks down on the ocean and the Cape—shook the nerves of the members of the Project Mercury team Scientists gingerly and carefully studied the data available on the flight before they made the decision to go ahead with plans of the following week to attempt to place a chimpanzee in orbit inside the Project Mercury spacecraft

The name of the thirty eight-pound chimp was Enos (which is a Greek word meaning "man") His quick responses during tests edged out two other chimpanzees for the honor—if it is so considered in the animal kingdom—of orbiting the earth The Atlas D lifted Enos in his contour couch at 9 07 A M on November 29 For nearly two full orbits everything worked perfectly as Enos continued to punch a lever every time a signal flashed If he punched the lever soon enough he got a banana pellet If he lagged behind too far he received a mild electric shock Later it was learned that Enos was prompt in punching the lever most of the time, but there was a malfunction in the system that gave him a shock

anyway Imagine, if you can, a chimpanzee lying on his back up there in space and getting perhaps a little bit mad every time he performed his duty properly and still got an undignified and totally unjustified electric shock If he thought about it at all he must have considered this an inconsiderate way to treat a hero to say the least

Nevertheless his continued devotion to punching that little lever sent a steady series of radio signals to tracking stations all around the globe indicating that he was still healthy and hungry This was why the banana pellet test was arranged Undoubtedly, there were smiles at every tracking station when the radio signal came in that he was still in there purposefully punching away No one knew at the time that he was getting shocked while doing his duty But near the end of the second orbit another set of radio signals began to come in The first sign of trouble showed up on the telemetry receiver at the Muchea Australia, tracking station There were indications that some of the spacecraft s electrical equipment was over heating, but, even more serious, the delicate attitude control system was not functioning properly One of the roll jets was faulty It was vital that the spacecraft be in a very precise attitude at the instant the retro rockets were fired, otherwise Enos could miss the recovery fleet by hundreds of miles or as happened with one of the Russian satellites could be fired off at such an angle that the spacecraft would burn up on a steep plunge back to earth A still more critical area was the reentry attitude If the hydrogen peroxide jets couldn t stabilize the capsule at this point Enos could also burn up

In Mercury Control at Cape Canaveral the reluctant decision was made not to attempt the planned third orbit for Enos but to try to bring him down at the end of his second orbit At 12 08 P M — three hours after launch — the tracking station at Point Arguello, California sent a radio signal to Enos's spacecraft that fired the retro, or braking rockets and started Enos on his gradual descent to earth Twenty minutes later Enos landed safely in the Atlantic 255 miles southeast of Bermuda A Navy destroyer picked him up and raced him to Kindley Air Force Base on Bermuda for a physical examination Enos showed no ill effects whatsoever from his 56 000-mile space flight Doctors analyzed his flight record and discovered he had performed throughout as a pretty cool chimp While he was atop the Atlas rocket waiting out the countdown he had actually gone to sleep Then at lift-off he suddenly awoke and — in the mysterious fright of the monkey world — his pulse suddenly shot up to 150 beats a minute But it quickly settled down to a normal (for a chimpanzee) 112 beats per minute He seemed unconcerned about flight in orbit At a press conference following his thorough physical exam — which revealed nothing wrong not even anger over the unscheduled electric shocks — he appeared bored with all the attention he was getting Remarkably, he was still interested in banana pellets

The trouble that had developed in Enos s capsule — particularly the difficulty with the attitude jets — meant it would now be virtually impossible to attempt to orbit an astronaut in 1961 At the press conference at the con-

clusion of the Enos flight, however NASA officially announced the name of the next U S astronaut They selected a man we expected them to pick and wanted them to pick as the first American to attempt to orbit the earth The name of the officially selected astronaut was John Hershel Glenn, Jr

I did not know John well but had talked briefly with him at Canaveral a number of times when he had helped me understand some technical point about space flight that I was writing on for *Time* and *Life* I had always found him modest cooperative very friendly and extremely dedicated to his mission He had extensive knowledge of the subject of space flight and, in addition had the happy faculty of being able to communicate that knowledge

Colonel Glenn who hailed originally from the small town of New Concord, Ohio had flown fifty nine combat missions for the Marines in World War II and ninety more during the Korean War, gathering a total of four Distinguished Flying Crosses and nineteen Air Medals in the process The oldest of the astronauts he was a calm industrious dedicated man greatly admired by all who came into contact with him

In late January when newsmen and scientists again converged on Cape Canaveral the atmosphere was entirely different from that of the two preceding suborbital flights Colonel John Glenn s proposed orbit of the earth was of course much more ambitious and — if successful — could furnish us with much more useful information

about space flight In addition, a great many more people were involved, as well as the entire circumference of the earth Roughly two thousand persons were directly employed in support of the mission at Cape Canaveral alone Another fifteen thousand men stood by for recovery or rescue operations on three aircraft carriers and twenty smaller ships stationed at sea Altogether there were eighteen fully staffed tracking stations which formed a band all the way around the earth on four continents and — on ships at sea — in two oceans And finally, another fifteen thousand scientists technicians and factory workers, who had helped prepare for this shot for four years, had a highly personal stake in the outcome Some of these men had helped build capsule number 13, which John Glenn had named Friendship 7, after consulting with Annie Dave and Lyn Friendship 7 was almost custom-made for three orbits of the earth It had more oxygen hydrogen peroxide fuel and food aboard than either Freedom 7 or Liberty Bell 7

Another important difference on this shot, of course was that the spacecraft would be launched not by the familiar Redstone but by the much more powerful Atlas rocket The official name of the proposed flight was MA-6 (for Mercury-Atlas number 6) This was the rocket that Alan Shepard along with John Glenn, had watched lift off on an earlier test with an unmanned spacecraft at its tip, then erupt over Cape Canaveral in a spectacular explosion that blew its electronic brains out

When I arrived in Cocoa Beach, it was impossible for me or any reporter to see John Glenn and perhaps, for

his sake it was just as well By his own choice he had been living for several weeks at the special astronaut quarters at hangar S inside Cape Canaveral He came off the Cape briefly every three days to get a haircut, since he had to keep his hair neatly trimmed so his head would perfectly fit his precision made space helmet Once he accidentally broke off a tiny piece of one tooth and drove off the Cape to a dentist s office to have the tooth filed down Each Sunday he attended the tiny Riverside Presbyterian Church in Cocoa Beach Once as his own supreme moment approached, he heard the Reverend Charles Pfeiffer preach a sermon titled Supreme Moments

John Glenn needed all the encouragement he could get — there had been a series of disappointing postponements of MA-6 By Saturday January 27 the orbit attempt had already been postponed six times because of a combination of bad weather and technical difficulties It was on this day with the weather still threatening that America s third astronaut awoke shortly after midnight took his physical exam from Bill Douglas and went through the intricate procedure — akin to that of a matador putting on his suit of lights — dressing for space flight That cloudy Saturday morning he remained atop the Atlas rocket for five long hours and eleven minutes before operations director Walter Williams canceled the flight for weather just twenty minutes from scheduled lift off

Although John Glenn was the picture of disappoint-

ment as he made the long journey back to hangar S, he sent word to the American people to stop worrying about him 'Just tell them to relax, he said according to Shorty Powers They should stay relaxed I ve been at this thing for three years now and I feel fine We regret the delays, but it gives us a chance to hone our capabilities'

During the frustrating wait I closely questioned a number of people who had helped John Glenn get ready inside the capsule I knew that on previous shots the astronauts had played small jokes on one another — mainly to relax the astronaut scheduled to fly On the Alan Shepard shot for instance John Glenn had pasted a small sticker in Alan's spacecraft reading, No handball playing in this area" On the Gus Grissom flight Gus had been handed a box of crayons because a popular comic song mentioned an astronaut who wouldn t leave the earth without his crayons and coloring book I learned of a similar example on the John Glenn shot Someone had carefully drawn the figure of a girl on the side of John s periscope and had printed under the drawing the words ' It s me and you John baby against the world

During the delay, I also talked to psychologist Dr Robert Voas and astronaut physician Dr Stanley White Both agreed that John Glenn was holding up well

'The only way you could make him anxious' said Dr Voas "would be to threaten him with the substitution of another astronaut'

'If these were holds that something could be done

Astronaut John Glenn checks his equipment

about,' said Dr White, 'maybe he would fret a little bit, but you can't do anything about the weather So far we're not worried in the slightest about overtrain He gets plenty of time to relax and he knows exactly how to do it We're not hovering around him all the time, but we do of course, watch for changes in attitude So far, we've found none He's in top form"

When the weekend approached, Dr Voas suggested that Glenn take in Marineland, a marine exhibit some three hours' drive up the coast but John preferred to remain behind the gates of Cape Canaveral

But the delays couldn't go on forever On the morning of Tuesday February 20 John Glenn and his backup astronaut Scott Carpenter were both awakened at 2 20 A M by Dr Bill Douglas Astronaut Deke Slayton joined them for an early morning breakfast of scrambled eggs and filet mignon in hangar S Then at 3 A M Douglas began the physical exams Both astronauts checked out fine By 4 48 A M Glenn had finished the intricate dressing procedure and had completed the suit pressurization tests As he left hangar S in his gleaming space suit he carried his portable air-conditioner in one hand and waved at the spectators and well-wishers with the other By 6 A M, when he walked almost jauntily up to the giant Atlas tower there was still so much cloud cover that the moon was only occasionally visible

There were the usual last minute frustrations One of his helmet mikes didn't work so they replaced it with a spare from another helmet While his door was being bolted on, one of the sixty-four bolts broke and it took

forty minutes to replace the hatch It took another twenty four minutes to replace a faulty liquid oxygen valve in the loading system

Now, miraculously, as the sun rose the clouds began to melt away as weathermen had predicted At the tense press camp Shorty Powers announced that all systems were go and the astronaut was ' go

In the blockhouse and in Mercury Control there were silence and steeled nerves

The ninety three foot Atlas rocket — with John Glenn at its tip — stood poised and waiting gleaming white with frost in the morning sunshine

All around the nation millions of people sat glued to their television sets waiting for a modest American to be hoisted into the unknown world of danger adventure and discovery

John Glenn in an incredibly matter of-fact voice, repeated the final seconds of the countdown ' Four three two one zero Ignition!

Precisely at 9 47 on a cool Florida morning the mighty Atlas belched out a horizontal column of white hot fire which instantly turned the coolant water into great clouds of yellow and pink steam As the rocket lifted John Glenn s pulse rate ticked off on the oscilloscope in Mercury Control It was a relatively placid 110 beats a minute (Shepard s had been 139 Grissom s had been 170)

Now the powerful space booster began to build up speed thrusting upward climbing true *roaring fire* A fifteen knot breeze shredded the lower section of the

dancing column of flame over seventy feet long A great crescendo of cheers swept the public beach and the press site

The ever-present contagion of a major rocket launch was combined with the powerful twin emotions of pride in John Glenn and anxiety over his fate in the new realm of space

"Lift-off," Glenn had stated initially "The clock is operating We are under way Now like Alan Shepard and Gus Grissom before him he began to report technical information to the ground almost as rapidly as he could speak

After a minute of climbing flight into a crisp blue sky, the rocket built a brief contrail in its wake At 131 seconds after lift off we saw a little puff as the two big booster engines dropped off Reported Glenn barely showing in his voice the strain of G forces now building up, 'I see the tower go [the escape tower] I saw the smoke go by the window I have the tower in sight, way out'

As the Gs piled on — building up to eight Gs — he continued to report clearly and emphatically After three minutes the rocket was still in sight as it thrust upward gaining orbital speed Bermuda reported it already had a track as a second brief countdown began high in the heavens "Twenty seconds ten seconds " Then Glenn reported, "Posigrades [small rockets] fired O K'

We could no longer see the MA-6 rocket at this point but we knew that if everything worked properly John Glenn should be in orbit There was a long moment of

suspense until Glenn announced with a touch of exuberance "Zero G and I feel fine Capsule [illegible] turning around That view is tremendous Capsule turning around and I can see the booster doing turnarounds just a couple hundred yards behind It looks beautiful "

Curiously enough newsmen did not cheer at the official confirmation that the first American was in orbit Everyone there was already very much concerned with getting John Glenn back safely Said Chuck Von Fremd of CBS "I ll save my cheering until John steps out on the deck of that aircraft carrier

Glenn probably already sensed it — especially when he felt zero G — but he got the word that he was officially in orbit from capsule communicator Alan Shepard at Mercury Control Said Shepard to Glenn, You have a go for at least seven orbits' (Alan was referring to capsule capability only three orbits were planned) Replied Glenn happily, "Roger, understand go for at least seven orbits'

High speed computers at the Cape had already calculated his flight data His speed at insertion (into orbit) was 25 725 feet per second His apogee (maximum height) would be 163 nautical miles His orbital period was 88 minutes and 29 seconds

From his great height John Glenn now had a magnificent view 'Can see clear back to a big cloud pattern back across the Cape Beautiful sight

But at his unearthly speed he was quickly leaving the Atlantic seaboard behind Since his spacecraft so far was operating perfectly on the automatic system he had

plenty of time to read and report on his instruments Everything was "go" cabin air 90, cabin pressure steady at 5 7, suit temperature 65 and "comfortable

Only twenty-six minutes after launch he made his initial contact with the Kano tracking station in Africa, just after he passed over the Canary Islands He reported cloud over the Canaries and that he had a clear view of a long section of the African coast He crossed into Africa just south of the town of Villa Bens Then his course took him north of Lake Chad and Lake Victoria While over Africa he performed the first of several experiments by eating malt tablets and squeezing a tube of applesauce into his mouth He reported swallowing was no problem

Your tongue forces it back in your throat and you swallow normally' he reported later 'It s all a positive displacement machine all the way through' He also shook his head violently to see if he felt anything like the dizziness Herman Titov had felt after six orbits He still felt fine "No nausea or discomfort whatsoever' he reported At 10 28, just after crossing the northern tip of Madagascar, he made his first contact with the tracking ship in the Indian Ocean It was now growing dark beneath him Just twelve minutes later he was in contact with his friend and fellow astronaut Gordon Cooper at the Muchea, Australia, tracking station 'Hello, Coop," he said this is Friendship 7 reading you loud and clear

Asked Cooper, How are you doing Colonel?' Replied Glenn 'We are doing real fine up here Then he described his reaction to the briefest day ever experienced by an American 'That was about the shortest day

I've ever run into Just to the right I can see a big pattern of light apparently right on the coast' Then Cooper explained that it was the Australian cities of Perth and Rockingham whose inhabitants had turned on their lights and spread white sheets outside windows to reflect the light upward Glenn radioed, Thank everyone for turning them on will you?

Now as his mercuric course carried him over the vast darkness of the Pacific he studied previously selected star patterns to see if he could see more stars from space than he could from earth In mid Pacific he encountered his first sunrise and in the process reported a fantastic phenomenon At first he said later I thought the capsule had gone up while I wasn't looking and that I was looking into nothing but a new star field But this wasn't the case There were thousands of little particles outside the cabin They were a bright yellowish green about the size and intensity of a firefly on a real dark night As far as I could look off to each side I could see them But he was moving on into the brilliant light of his second day sun and the mysterious particles disappeared

It was while he was over Mexico on his first orbit that he experienced the first difficulty with his attitude control system At least one of the yaw jets or thrusters which emit hydrogen peroxide steam began to malfunction During the long delays on the pad some McDonnell engineers had become concerned that corrosive action might threaten to clog the system and it was possible now — even though the system had been repeatedly

flushed out — that the effects of corrosive activity were causing a valve to stick

When Glenn passed over the eastern United States using a semi automatic control system known as fly-by-wire, Alan Shepard asked him 'Would you give us the difficulties you were having in the yaw?" Glenn replied 'It just started, as I got to Guaymas and it appears to drift off in yaw to the right at about one degree per second It would go over to an attitude of about twenty degrees, then hold, then goes into orientation mode and comes back to zero It was cycling back and forth in that mode'

John Glenn was obviously neither overconcerned nor severely preoccupied, as shown by his almost casual report of the beautiful view out the window as he crossed the United States Atlantic coast Just before he passed out of Shepard s range he again returned to the strange particles he had seen The only real unusual thing so far besides the ASCS trouble' he said, 'were the little particles, luminous particles around the capsule just thousands of them right at sunrise over the Pacific

On the ground at Cape Canaveral I asked a scientist what his explanation of the luminous particles was His theory has yet to be fully verified but it could possibly be the answer He said the particles could be clusters of moisture or gas molecules given off by the capsule in three ways — as steam from the hydrogen peroxide jets as moisture from the air-conditioning system and as gas given off by the metal itself in a near vacuum (a process

their minds was whether or not they should believe the indication that the switch which holds the heat shield on was actually open Said Yardley at one point, 'If it is open and unless we do something it s sure death on reentry ' The only logical alternative that presented itself was to change the normal flight procedure and leave the retro package on during reentry The theory was that the three straps which held the retro package on would also — until they melted — hold the heat shield in place After the straps melted there should be sufficient atmospheric pressure to keep a loose shield in place The only trouble with this procedure was that it had never been tested in anything except a wind tunnel No one really knew if it would work in space The decision not only involved a difficult ' calculated risk ' it also involved the survival of John Glenn

As John Glenn circled in his third orbit a decision had to be made The man primarily responsible for that decision was Walter Williams, operations director Williams from time to time left the main Mercury Control room to confer with Yardley and others in a small adjoining room He also conferred with flight director Chris Kraft astronauts Slayton and Shepard and NASA engineers Don Arabian and Walter Kaplan

At one point Williams told everyone he wanted their recommendations by ten minutes from retrofire There was minor disagreement but the most authoritative and prevailing opinion was that the retro package should be left on Word was flashed to Glenn from astronaut Wally Schirra in Hawaii to leave the retros on When

the retros fired Glenn said, "It felt like I was going clear back to Hawaii" After retro firing, as he passed over the Corpus Christi tracking station, capsule communicator (called Texas cap com) George Guthrie asked him if he knew why he was told to leave the retros on "Yes I think I do," replied Glenn But as he went back to other duties he gave no indication that he was unduly worried The scene in Mercury Control, however, was one of hidden but deep and intensifying concern as the tracking boards showed Friendship 7 approaching the point of maximum pressure and heat Even Shorty Powers, who tried to discipline himself to keep his voice calm began to show the strain As he announced that landing area weather was one-tenth cloud cover and ten miles visibility (very good) his voice had a worried edge The concern was heightened by the fact that, as expected, all voice and radar contact with the spacecraft was lost during the most critical part of reentry This was because the ionization layer that forms around the capsule during the searing heat of reentry blocks all radio signals

After an agonizing period of over four minutes of radio silence, John Glenn's southern Ohio accent came on suddenly "Boy" he said excitedly "that was a real fireball" The world of Cape Canaveral and the world everywhere sighed in thankful relief We knew he had survived reentry

From then on optimistic reports flooded in every few seconds The drogue — or stabilizing — chute was deployed at 2 37 P M, and a few minutes later the main sixty three foot chute blossomed against the blue sky

Said Glenn, "That's probably the prettiest sight you ever saw in your life ' Ships picked up his radar chaff at 2 39 U S S *Noa*, which was only six miles away, reported him on the water at 2 43 *Noa*, in a race with helicopters from the aircraft carrier *Randolph*, got to him first and had him aboard eighteen minutes after his hot capsule hit the waters of the Atlantic

A still perspiring John Glenn blew off the side hatch, stepped out on deck and asked for a glass of iced tea The first American to orbit the earth had been safely recovered

Any American who had just orbited the earth three times would have become a kind of instant hero But John Glenn's particular warmth and personality brought to his daring and his remarkable accomplishment an extra dimension which Americans everywhere were quick to appreciate Even before he returned to Cape Canaveral his human as well as technical response to space flight had assured him of almost universal admiration His words about the beauty of space flight his thoughtfulness toward the people of Perth, Australia — who had turned on their lights for him — his at times humorous reaction to his unique situation had all been broadcast to millions by the time he reached Grand Turk Island for his complete post-flight physical exam The nation was accustomed to making its heroes out of TV stars such as actor-cowboys detectives and policemen, or young musicians like Elvis Presley Suddenly the country had a hero cut from an entirely different cloth altogether — a bona fide and humble observant and articulate man of skill and

daring who had faced undeniable and unprecedented dangers with confidence, poise and balance There was nothing artificial about John Glenn

So it is not remarkable that when he returned to Cape Canaveral the little town of Cocoa Beach poured out its heart to him in a mass expression of fulfillment

Long before his plane landed at nearby Patrick Air Force Base, men, women and children began to assemble near his parking ramp By the time his parents arrived in a black convertible some five thousand people had collected at the airport 'Why imagine Mrs Glenn exclaimed 'President Kennedy sent his own plane for us Wasn t that a nice thing to do? Mr Glenn kept searching the skies for the twin-engine plane that was flying in his son and Vice President Lyndon Johnson 'That s him now, he said finally with a quick smile

As John Glenn dressed in a neat dark suit and tan and white tie, stepped out of the Lockheed Jetstar, a great cheer went up After Glenn hugged and kissed his wife Annie long and hard he hastily wiped his eyes then grasped David and Lyn and gave his mother a long hug His father just shook his hand and said, How re you doing son?" It was obvious John Glenn was doing all right His tan face was wreathed in smiles As the cheering continued someone waved a banner back and forth that read WELCOME TO EARTH Another sign read simply, THANKS JOHN GLENN

Then a parade began that Cocoa Beach residents will long remember Glenn sat on the back seat of a convertible with one arm firmly around Annie As he ap-

proached women held up children, babies even dogs One woman standing beside the road played a solo on a trumpet On the lawns of plush motels steel drum and calypso bands blared out welcoming music People stood and sat on roofs, on ladders and where construction was going on on tractors and earth movers

There was no school that day in missileland On the previous day — George Washington s birthday — hundreds of schoolchildren had fashioned homemade flags and red white and blue paper hats and pennants All along the parade route entire classrooms of schoolchildren waved their trophies and shouted One sign read GLENN DO IT AGAIN Another read OHIO LOVES JOHN GLENN It was a heartwarming parade of grass roots Americans pouring out their gratitude to a man whom they had made one of their own So many people swarmed around the car that it took an hour to cover the fourteen miles to the south gate of Cape Canaveral

Inside the Cape at the so called skid strip where air breathing Snark missiles had once landed after long flights downrange President Kennedy landed in his jet Glenn and the Vice President marched smartly up to greet him before they were stormed by a pressing mass of people that threatened to crush them against the waiting burgundy colored Mercury convertible After Glenn and the President toured Mercury Control Center pad 14 and ICBM Road their car brought them to the platform and microphones that had been erected just outside hanger S where Glenn had waited out so many long nights Thousands of Cape workers — some of

them in hard hats — stood on nearby roofs or mingled in the crowd of office workers and secretaries To the left of the platform was a gleaming new Mercury capsule that contrasted markedly with the scorched and blackened Friendship 7 standing at the opposite end of the platform The words UNITED STATES were tarnished black on Friendship 7 and the heat shield plainly showed ablation effect it was covered with a grayish and pebbled ash The entire capsule looked as if it had really been cooked

On the platform were the astronauts President Kennedy, Vice President Johnson and two rows of Congressmen The President said, 'We have a new ocean and called John Glenn the admiral of that ocean The crowd roared its approval when the President said Our boosters may not be as large as some others but the men and women are' As John Glenn received NASA's Distinguished Service Medal and as he stood up to speak the missile workers of Cape Canaveral gave their appreciative applause 'Sit down, please' Glenn began 'It's hot' He again referred to himself as a symbol and representative of all those who had been involved in the shoot "I can't express my appreciation adequately when I know how many thousands of people over the country helped accomplish what we did last Tuesday Thousands have contributed as much or more than I'

The 'we he used was reminiscent of another we used by another colonel, Charles Lindbergh in 1927 Glenn's speech was dedicated primarily to sharing the credit Both he and the President were saying that not

one man but a whole people had achieved a milestone in space flight The accomplishment meant even more because of the known hazards of missile research and development There had been many errors and failures, but this was an event that made our failures seem valuable lessons on the road to this kind of accomplishment

Later at his press conference in the big tent at the Cape Canaveral press site, Glenn gave the first narrative account of his flight He described the chunks of flaming debris that had swept by his window as the retro package burned off in the three thousand degree heat of reentry There were moments of doubt whether the heat shield had been damaged he said If that had happened it might have been a bad day all around He like Shepard and Grissom before him called the weightless state a very pleasant experience I probably am becoming a zero G addict He was particularly impressed with the beauty of the sunsets "As the sun goes down," he explained, "it s very white brilliant light and as it goes below the horizon you get a very bright orange color Down close to the surface it pales out into a sort of a blue a darker blue then off into black The awesome silence of space did not bother him at all 'I could hear the whine of inverters and the hiss of oxygen and these were comforting sounds He again described the amazing phenomenon of the luminous 'fireflies he had seen at all three sunrises and drew a huge laugh when he said one of the psychologists who had inquired about the particles had asked "What did they say, John?

Six days after his epochal flight, three hundred thou

sand persons stood in the rain to pay tumultuous honor to John Glenn as he drove down Pennsylvania Avenue to the United States Capitol Before a joint session of Congress, the Cabinet, members of the Supreme Court and the Washington diplomatic corps Glenn was greeted with one of the longest standing ovations ever recorded in Congress

This has been a great experience for us all," he told Congress "and I am glad to see that pride in our country and its accomplishments are not a thing of the past I still get a hard to define feeling inside when the flag goes by and I know all of you do too Let us hope that none of us ever loses that feeling'

Characteristically, he introduced each member of his family, the other astronauts present, operations director Walter Williams, then in an open-armed gesture that warmed the heart of every woman present, he introduced Annie as the real rock in our family His childhood sweetheart from New Concord Ohio stood up in the gallery and was enthusiastically applauded

He then commented on the program as a whole and plans for the future 'These are the building blocks" he said, "upon which we shall build much more ambitious and productive portions of our program The Mercury spacecraft and system s design and concept are sound and have now been verified during manned flight We also proved that men can operate intelligently in space and can adapt rapidly to this new environment Zero G or weightlessness—at least for this period of time—appears to be no problem As a matter of fact

lack of gravity is a rather fascinating thing Objects within the cockpit can be parked in midair For example, at one time during the flight I was using a hand held camera Another system needed attention, so it seemed quite natural to let go of the camera, take care of the other chore in the spacecraft, then reach out, grab the camera out of midair and go back about my business

"It's hard to beat a day,' he said at one point 'in which you are permitted the luxury of four sunsets After explaining that he had flown up from Palm Beach that morning with President Kennedy and the President s daughter Caroline he added, I think Caroline really cut us down to size and put us back in our proper position, though when after being introduced she looked up and said Where s the monkey? All this' he said as the crowd roared 'and I didn t get a banana pellet on the whole ride

'We are proud to have been privileged to be part of this effort he concluded As our knowledge of the universe in which we live increases may God grant us the wisdom and guidance to use it wisely

Later to a committee of Congressmen, Glenn echoed an ominous warning of personal peril ahead We don t envision every flight coming back as successful as the three so far he cautioned There will be failures there will be sacrifices

Even as the applause died down on Capitol Hill the nation s largest city New York was getting ready to welcome the astronaut Five days later Glenn landed at

New York's LaGuardia Airport and proceeded to Manhattan for a traditional ticker tape parade An estimated four million people poured out their pride and joy as John Glenn and Annie and the other astronauts drove by Office workers hurled ticker tape, streamers confetti and other paper of all sizes and colors from the tall buildings Traditionally, the total weight of all this paper has been regarded as an index of parade enthusiasm In 1927, when Colonel Charles Lindbergh was given a parade in New York, sanitation department workers removed 1750 tons of paper from the streets The all time paper record had been set in 1952 when General Douglas MacArthur was showered with 3249 tons of paper After the John Glenn parade, however, 3474 tons — a new record — had to be hauled away

At welcoming ceremonies in New York an interested observer was Sir Harry Howard, the lord mayor of Perth, Australia, one of the cities that had turned on its lights for Friendship 7 "When the lord mayor of Perth showed up," cracked Glenn, "I was afraid he might have brought the light bill with him"

The next day Glenn attended a meeting of the United Nations Committee on the Peaceful Uses of Outer Space There he gave a twenty minute talk to members of twenty-eight countries who made up the committee "International teamwork Glenn told them 'must govern man's exploration of outer space As space science and space technology grow still further and our projects become more and more ambitious we will be relying more and more on international teamwork And the nat-

ural center for that teamwork in the United Nations"

But perhaps the most meaningful parade of all came in his hometown of New Concord, Ohio There, surrounded by his childhood friends his teachers and college professors and coaches, he was nearly overwhelmed with the emotions of a stirring homecoming 'Let's just say it s great to be an American he told his audience in the college gymnasium "and it s great to be home

As the cheers finally died down Americans everywhere settled back to work But they now had a new light in their eyes and a new lift in their hearts One of the country s small town boys had not only made good he had also reaffirmed our faith in hard and dedicated work and, even more important had reaffirmed our faith in the eternal spirit of man In the coming decades of extended space exploration there would be many opportunities to gaze backward to the pioneer astronauts In the case of John Glenn that look backward would assuredly rest on an explorer who, in crossing the soundless barrier between the past and the future had given new meaning to our sense of adventure of discovery and of wonder

13

Scott Carpenter in Aurora 7

BY MAY 1962 the score still stood at two orbital space flights by the Russians and one orbital and two suborbital flights by the United States Now it was time for the United States to attempt another three orbit shot, designed to test further the various functions of our spacecraft especially the attitude control jets which had given John Glenn so much trouble Because Glenn had encountered his difficulty early he had spent a great deal of time actually flying the spacecraft, at the cost of omitting a number of assigned tasks and experiments

The astronaut originally selected to follow John Glenn was Donald (Deke) Slayton, of Sparta Wisconsin, but the powerfully built and rugged looking astronaut had unexpectedly developed a mild heart murmur that caused doctors to withdraw him at least temporarily, from the flight program Deke was deeply disappointed and announced his hope that his slightly erratic heartbeat would become normal again For the launch of Aurora 7 he had to content himself with the secondary role of flying to Australia he would man the tracking

station there and communicate with the spacecraft as it orbited overhead

Moved up to fly in Aurora 7 was one of the most popular of the astronauts, Malcolm Scott Carpenter, thirty-seven, of Boulder Colorado Scott Carpenter looked like a Hollywood casting director s idea of an astronaut He was tanned crew-cut, handsome and was lean and superbly coordinated His handsome family complemented his own appearance His thirty-four-year-old wife Rene (pronounced 'Reen') was a blonde, dimpled beauty who, like her husband, obviously enjoyed moments spent with their four lively children At Cape Canaveral the family sometimes held cookouts on the beach, and Scott sometimes brought along his ukelele to entertain the kids

To Scott Carpenter the astronaut program was not only a superb adventure, it was a mission that gave his life meaning and direction Scott describes himself as a boy as 'sort of no good' during his days of hunting and fishing on Table Mesa in the Rockies After his mother went to a sanitarium, he was raised by his grandparents "I had a wonderful time," he told a *Life* reporter "but I was a real rounder I didn t study hard, and I had to quit high school football because I couldn t devote myself to learning the plays I stole things from stores and I was just drifting through He continued to drift even in college, and he twice flunked out of the University of Colorado before an accident in his hot-rod Ford put him in the hospital for two weeks with a broken leg and collapsed lung In the hospital he thought over his life and decided he could do better He reentered the university

and this time completed the work except for one course, then he entered Navy pilot training When World War II ended he was still a cadet, but he saw service in the Korean War as a patrol pilot of a P2V in the South China Sea He later became a test pilot Then his Navy career took a dip when he was assigned to desk duty The thing that salvaged his morale was the announcement of his appointment to Project Mercury He immediately got himself in top physical shape Later at Cape Canaveral he continued to keep in shape by working out on the trampoline and by lifting weights His Project Mercury specialty was capsule communication and navigation In the astronaut program he had finally found the challenge that gave his life a meaningful purpose

At 1 45 on the morning of Thursday, May 24 Scott had a filet mignon breakfast with John Glenn and Bill Douglas His backup man and 'shadow for the past few weeks, astronaut Wally Schirra thirty nine was already out at complex 14, checking out the Aurora 7 cockpit But an hour later Scott had completed his physical exam and was as usual in top condition Again there would be no substitution of astronauts When he arrived at the launch pad at 4 A M he encountered a sign which read, WELCOME TO COMPLEX 14 LAUNCH SITE OF FREE WORLD'S FIRST ICBM, FREE WORLD S FIRST MAN-IN-ORBIT He also became the first astronaut to encounter a perfect countdown So far every one of the thousands of components was functioning properly This unusual go status of the perfect countdown continued right up until T minus 11 minutes when the count was held to allow the morning

haze to burn off over the Cape During the forty five minute delay, Scott — resting on his back in the space craft — called his wife and family who were watching the Cape from a secluded beach house Rene Carpenter was the first astronaut wife to insist upon watching the launch from the beach All the other wives so far, had watched the launches on their living room TV sets far from Cape Canaveral Scott talked to Rene and then to each of their four children Gradually the haze thinned out Finally the sun flooded the Cape with light One of the last tasks performed for Scott Carpenter is familiar to any driver who goes to a filling station — his windshield was cleaned

At 7 45 the complicated internal chemistry of the Atlas booster erupted into a powerful spurt of fire and steam Aurora 7 was lifting Ten minutes later the space craft with Scott Carpenter inside entered a trajectory that capsule communicator Gus Grissom told him was "good for seven orbits Speed was 17 532 miles per hour Apogee was 167 miles Perigee was one hundred miles

When Scott felt the rare effects of complete and buoyant weightlessness and learned from the ground that he had hit the keyhole in space that signified a success ful orbit he replied Sweet words

As everything continued to work normally his task was to perform experiments to supplement the informa tion John Glenn had obtained Scott had a camera with him and at the first opportunity he started photograph ing cloud formations He also performed polarization

and other tests including exercising with the thick rubber bands attached to the instrument panel Twenty-three minutes after lift off he was talking with the Kano Nigeria tracking station Seven minutes later the Indian Ocean tracking ship reported he had passed by At 8 35 — fifty minutes after lift-off — he talked to Deke Slayton in Woomera Australia As he passed over Woomera one million candlepower flares were set off but, unfortunately, he reported no visual contact due to cloud cover in the area

His first difficulty was encountered as he swept over the Pacific The temperature inside his air-conditioned suit went up to around one hundred degrees and, as he struggled with the air flow adjustment valve, he reported he was sweating profusely At one point he observed a small washer floating in the cockpit He picked it out of midair Orbiting over Guaymas, Mexico he pressed the button that inflated a multicolored ballon thirty inches in diameter that was tethered to the capsule by a one-hundred foot nylon cord The balloon didn t fully inflate but he reported which of the various colors were best visible in space and spent fascinating minutes observing the random antics of the balloon He reported that the balloon drifted from side to side like a slower version of a child s balloon trailed from a car At the end of the second orbit he tried unsuccessfully to release the balloon Scott had been using the manual controls quite often and once during a busy period, had accidentally used two fuel systems at the same time As as result hydrogen peroxide fuel was running out too quickly and he

was advised to let the capsule drift as much as possible This advice evidently worked for a while as — at 10 46 A M — Mercury Control announced Aurora 7 was going for a third orbit Carpenter was also advised to drink as much water as possible as he continued to have difficulty with his suit temperature

Several times during intervals in his busy schedule he reported seeing snowflakes outside his spacecraft window On the ground speculation arose that these might be the fireflies John Glenn had reported

At 12 07 Carpenter passed over the Hawaii station on his third orbit and was told to go into orbital attitude As he approached the west coast of the United States at 12 18 his retro rockets fired and his speed began to drop fairly rapidly from 17 500 miles an hour Six minutes later over Texas cap com he reported that his fuel system was low Mercury Control was tense as he arced down for reentry They were worried about his low fuel but they were even more worried about indications that he was not on the proper reentry path that would take him to the planned recovery area The last contact with Scott Carpenter was at 12 6 while he was over the Gulf of Mexico He was advised to secure all loose gear in the cabin and button up for the landing Then at 1 30 all signals from Aurora 7 suddenly ceased

As the world lost contact with Scott Carpenter and the long silence began people began to collect anxiously around TV and radio sets What had been up to now a fairly routine and undramatic repetition of the precedent

setting John Glenn flight suddenly became of tremendous importance People everywhere wanted assurance that Scott Carpenter was alive and on course for recovery As the minutes ticked off ominously radio and TV commentators began the long stall, trying to fill the great void of the unknown with hundreds of words that really told nothing new and meant very little Rene Carpenter and the four children huddled concernedly over their TV set at a Cape Canaveral beach house At Mercury Control the tracking boards and radar screens hummed expectantly, but nothing was reported

As twelve minutes went by without contact tension began to mount Scientists pondered the significance of Scott's last report to Alan Shepard in Point Arguello California, at the instant of retrofire "Al," Scott had reported, "I can t tell you what was wrong about the attitude, but the automatic gyros were not quite right Retro attitude was red" The scientists knew that if Aurora 7 was not in the desired thirty-four degree attitude at the instant of retrofire the spacecraft either might still be in orbit or might miss the planned recovery area completely Doubts and anxieties increased as the blackout period stretched to twenty full minutes Meanwhile some people in Mercury Control were pointing out that data analysis now definitely showed that Aurora 7 was going to miss the planned recovery area Recovery ships, including the carrier *Intrepid*, raced full speed for the predicted point of impact some 250 miles further downrange Air Force SC54s with 'pararescuemen' aboard

took off from Puerto Rico, and Navy P2Vs — which Scott had once flown — homed in on the expected point of impact

To the waiting world it was a full thirty-five minutes before word finally came that Scott Carpenter was safe One of the Navy P2Vs had been homing in on Aurora 7 s ninety one watt search and recovery beacon — known as Sarah It now reported that it had spotted Aurora 7 floating upright in the water with Scott sitting calmly nearby in his orange life raft A few moments later the lone P2V was joined by circling Air Force planes from Puerto Rico Unknown to Scott Carpenter — because it happened behind him — two pararescuemen jumped into the water and surprised Scott by swimming up to the raft One of their missions was to attach the new flotation collar to Aurora 7 to keep it from taking on water The first man to reach Scott was John Heitsch of the Air Force Scott gave him a startled look and asked How did you get here?" He then offered the two men water and food Cradled carefully in Scott s hand was the small camera with which he had taken color pictures of sunsets, snowflakes and cloud formations It was a happy ending after the longest blackout so far in our manned space program as Scott rode back in the rescue helicopter, he stretched from time to time and said, Wow!

Scott Carpenter — before the three hours he spent on the water — had spent five hours in space and had traveled 81 250 miles 250 miles more than John Glenn "My apologies for not having aimed a little bit better on reen

Scott Carpenter talks to President Kennedy

try,' he told President Kennedy by phone while aboard the ship

Three days later after being transferred from the USS *Intrepid* to Grand Turk Island in the Bahamas, Scott returned to Cape Canaveral to receive NASA's Distinguished Service Medal and to explain his flight to the assembled press He cleared up a number of points For instance the Kauai Hawaii, tracking station had reported earlier that he was a different ' possibly confused and tired man on his third orbit We had the impression," reported Kauai, "that he was very confused about what was going on But it was very difficult to assess whether he was confused or preoccupied He certainly was a different man on this pass than on the preceding ones

Scott had the following answer to this report "If my opinion is worth anything to you, this is not true I will admit to being preoccupied It was a very busy time The fuel consumption was not the fault of the capsule only the fault of an impatient man

Regarding the rise in suit temperature he reported, I got reports from the ground that my body temperature was one hundred two I don't believe this is so I didn't feel that I was that hot I was perspiring profusely but this may have been the result of being unable to control the suit temperature rather than from having the suit temperature too high Through a series of manipulations of the suit the water control valve I was finally able to arrive at a satisfactory setting I think we have a bet

ter idea now of how to design another system that gives better control of temperature '

Like John Glenn before him Scott remarked enthusiastically on the beauty of the sunset It is beautiful beyond description,' he reported, 'and so I won t really try The pictures will be available later, and you can judge for yourselves They lack realism in one sense A picture of a campfire doesn t really look like a campfire but you have a pretty good idea of what a campfire looks like from a picture It loses some of its realism because the picture doesn't glow The fire does not glow with its own light and when the sun is just below the horizon, the color bands won t glow with this same bright light that I saw, but the colors in the picture are true It is the most magnificent sight that I have ever seen '

Regarding the balloon experiment he explained that loops sometimes remained in the relaxed nylon tethering cord for as long as fifteen minutes 'We have some pictures of the balloon under different lighting conditions he pointed out, "and I think we can deduce from these pictures which colors give us the best visibility in this environment We also had this balloon mounted on a tension meter and I was able to make some measurements of the drag on the balloon which I hope will contribute to our knowledge of the density of the atmosphere at this altitude The fact that it did not jettison caused no problem

Even though he had accidentally used excessive fuel he reported that drifting flight—in which the capsule

could be in any attitude even upside down — was no problem This meant that fuel could be conserved on future flights by making more use of drifting flight

As Scott continued to report on his flight he began to sweat profusely in the crowded press conference on a hot day in Florida At one point when he reported his cabin temperature was 105 degrees a reporter said It s better than that in here Scott wiped his forehead smiled and said it sure felt like it He also drew a laugh when he explained that as he was being hoisted off his life raft into the helicopter there was a sudden settling that dumped him in the water but he thrust out his arm and held the precious film in the camera above water until the helicopter lifted him from the water I was happy to learn this afternoon he said that the film was completely dry and the pictures were good

Scott Carpenter perhaps best explained the value of his mission when he commented on what he called the heart and soul of science Isolated data points mean nothing Now through John Glenn s flight and my flight we have two data points on nearly everything that was observed His flight confirms mine and mine confirms his, and we have a much more solid background now

The several difficulties Scott encountered were all considered capable of correction on future flights NASA officials had previously announced that they would decide after Scott s flight whether to go for three orbits or six in the next try After considering all the factors involved in the flight of *Aurora 7* they decided to scratch another three orbit mission in favor of six flights around

the earth with a terminal orbit landing point in the Pacific

So far the Project Mercury manned flights had made up one of the most gratifyingly successful series of rocket launches in the short history of the space age The flights were far from perfect but — as Scott Carpenter emphasized — we were learning every bit as much from our mistakes as we would have learned from flawless performance

14

Wally Schirra in Sigma 7

FOR THE THIRD TIME in a single year, engineers, technicians and astronauts prepared to send another of their number into orbit. The date chosen for Mercury-Atlas 8 was Friday, September 28, 1962, and the man of the hour was to be thirty-nine-year-old Annapolis graduate Commander Walter M. Schirra. The tousle-haired astronaut, whose quick wit, ready smile and candidly outspoken nature were a delight to many of his friends, had been in training since July. His flight plan was designed to fill in the gaps not covered by John Glenn or Scott Carpenter and to answer some of the questions their flights had raised.

Schirra would also attempt to double the duration of previous flights, staying in space for six orbits, or approximately nine hours, with a capsule virtually identical to earlier models. If all went well, he would become the first Mercury astronaut to splash down in the Pacific Ocean, the most convenient landing point after six orbits. Northeast of Midway Island, where the carrier U.S.S. *Kearsarge* was on station, steaming slowly in circles

Most important of Wally Schirra s tasks during the longest U S spaceflight yet attempted was to determine the effects of long duration "drifting flight on both pilot and capsule In drifting flight all power to the capsule's small thrusters ■ cut off, making it temporarily impossible to control the capsule s alignment Instead of the customary stability with the capsule's nose pointing forward toward the distant horizon, Sigma 7 would drift at random, sometimes pointing straight up, sometimes straight down, sometimes backwards but always moving The need for this kind of orbital free flight was obvious because the spacecraft used none of its meager supply of hydrogen peroxide fuel, even longer flights might be planned in which an astronaut drifted when relaxing or sleeping and used his precious fuel only when stability was essential But if an astronaut became dizzy or disoriented, long duration drifting flight could become dangerous It was Wally Schirra's job to find out if it could safely be done

Wally Schirra was born in Hackensack New Jersey on March 12, 1923 His adventuresome love of flying came as no surprise to his parents The elder Schirra for whom Wally ■ named was a pilot who barnstormed his way across the country and the pretty girl who captivated crowds with her fearless wingwalking was none other than Wally ■ mother By the time he was twelve Wally was handling the controls above the New Jersey countryside under his father s watchful eye After graduation from the U S Naval Academy Wally took formal pilot training at Pensacola Florida and proved his

skill in Korea while an exchange pilot with the Air Force by flying ninety combat missions, downing one MIG with another probable, and winning two Air Medals and the Distinguished Flying Cross

While waiting and training for his flight in Sigma 7 he provided new evidence of his outspoken nature and, in the process, revealed the first public hint of even mild disagreement among the tight fraternity of the seven Mercury astronauts In an interview with Walter Cronkite of CBS he complained that John Glenn's numerous appearances and speeches around the country caused him to be "missed" at Mercury headquarters at a time when his flight experience was sorely needed Glenn didn't reply to the criticism publicly, but he made a careful list of his engagements all of which he felt were important to the future of space exploration He carried the list in his pocket in case Wally again brought up the subject but Wally decided not to make any more public statements and dropped the matter

It was just as well for the intensive preparation for his space flight in Sigma 7 demanded his full attention The primary difference between his spacecraft and those of Glenn and Carpenter was in the addition of a small electrical switch to allow Wally to disable the fuel-thirsty twenty-four pound thrusters and use only the economical one- and six pounders while controlling his ship in the manual fly by wire mode of operation

After more than 17,000 men were deployed around the world on recovery ships and aircraft the last detailed inspection of Sigma 7 revealed a faulty fuel valve in the

control system The flight was postponed for five days, until Wednesday, October 3

Throughout the long weekend and well into Monday, dismal weather clouded skies above and hopes below Forecasters checked the clouds their instruments and their instincts With fingers crossed they finally gave the flight a go

Shortly after 5 A M Wednesday Wally Schirra clad in his bulky and tightly sealed space suit, slid feet first into Sigma 7 At the astronaut s new home in Seabrook Texas only three miles from the Manned Spacecraft Center already rising from the coastal plain near Houston Jo Schirra and their children Wally III twelve and Suzanne five watched on television

The countdown went perfectly until 6 15 A M at T minus 45 minutes, essential radar tracking equipment at the Canary Island tracking station blacked out Fortunately to everyone s relief the station was back in operation after only fifteen minutes and the count was resumed At precisely eleven seconds past 7 15 Wally Schirra was on his way

I have the lift-off Wally reported happily And she feels fine '

From Mercury Control Center astronaut Deke Slayton capsule communicator retorted Wally you got a pin for this flight And Schirra quipped back Yeah I got the pins on my office wall

(The joke referred to one of Wally s rare goofs The pins were used to lock the landing gear on carrier based

Navy aircraft, and Wally frequently upbraided young pilots who forgot to remove them before takeoff preventing the wheels from being retracted When the inevitable happened and Wally himself forgot his younger squadron mates settled the score by presenting him the pins neatly mounted on a wall plaque)

Sigma 7 continued upwards atop the mighty Atlas Wally himself reported BECO (booster engine cutoff) and minutes later verified that Sigma 7 had separated from the Atlas sustainer stage Then the skilled astronaut switched to fly by wire and slowly turned his capsule around Only five minutes forty-four seconds after leaving Cape Canaveral Wally heard Slayton's report that he was good for seven orbits His cheerful reply was 'Say again I like that kind "

Switching to the automatic control system — what Wally calls the 'chimp mode' — he settled into his flight 'The sustainer is sitting very steady above me he reported "It is not oscillating at all I see no vapors it looks very clean'

Then startled ground controllers heard a discouraging report The temperature in Schirra s space suit was unaccountably going up For the next two hours as the problem continued they teetered on the verge of ending the flight early But to the calm if not cool astronaut the annoyance was only minor Without a single interruption in his duties he slowly changed settings on his cooling unit On his second pass over the Indian Ocean Wally ended the debate still going on at Cape Canaveral

"At last we have solved the suit circuit temperature problem he radioed 'The suit temperature is sixty eight degrees and I m feeling marvelous"

In the meantime Schirra had carefully checked his controls discovering that Sigma 7 responded easily to his touch even when the large thrusters were disabled Now he spent his first twenty minutes in drifting flight His reports continued to be clear and businesslike He later reported that when coming out of drifting flight he could stabilize the capsule faster even than could the automatic system It was a good sign

Only one of Schirra s planned experiments was doomed to failure He was to look for four brilliant flares at Woomera Australia during the first revolution and for an intense xenon light at Durban South Africa during his sixth revolution Such lights could perhaps become earthly navigation beacons for future space travelers But Schirra s report was negative heavy clouds obscured both sites

Another experiment however was totally heartening A dosimeter that was carried in the cabin for the first time, showed that Schirra had been exposed to virtually no radiation even though his orbit ranged upwards to the airless void of 176 miles high

But the critical test of the flight — to conserve fuel and determine the effects of unchecked drift — was still to come Exactly four hours after lift off Wally reported that he still had 90 per cent of his fuel remaining Shortly thereafter he pointed the capsule s nose directly at the horizon turned off all switches and settled

down to take pictures of the earth and to wait His own radio reports best describe the sensation

"I am in drifting mode, everything is working beautifully Ah boy, I just happened to drift into an inverted position right now For some reason or another, you can tell that the bowl was upside down I am just about straight down We will take some cumulus *[cloud] pictures Sun right in view again* There is a very, very slight pitch rate sunlight in my eyes now Get a tan on this flight at last

When the test was ended after nearly two hours of drift Schirra alertly restabilized Sigma 7 and reported no ill effects No trace of doubt remained that drifting flight would play an important role as fuel conscious engineers planned longer and longer future space missions

The ability of the Mercury spacecraft to fly by itself was particularly heartening to designers at McDonnell Aircraft who up to now had been impatient with astronauts who used the manual controls at every opportunity Privately Glenn and Carpenter had been referred to by at least one designer as stick jockeys', he naturally wanted above all to see his brainchild fly alone to fulfill one of its most demanding design criteria When he noted Schirra s successful drifting flight and resulting conservation of fuel he caused a burst of laughter in Mercury Control by remarking "Wally is the best pilot since Enos" (Enos was the chimpanzee who had preceded Glenn into orbit)

So successful had the flight been to this point that Wally went ahead with a daring test known only to him-

self and a select few on the ground. With 90 per cent of his manual fuel remaining, the astronaut purposely cut himself off from all contact with earth. No radio message could reach him. No signal could be received by his automatic retro rockets. He was alone and on his own. Only the on-board tape recorder faithfully picked up his reports.

For the next twenty-six minutes Wally's skillful hands put Sigma 7 through its paces. Alternating from automatic to fly-by-wire, he found that it was possible to detect attitude changes by watching stars and that an astronaut can easily point the capsule anywhere he desires with very little fuel use in manual control. He even took time to photograph clouds for the Weather Bureau and to describe the bands of color at the earth's horizon.

With the valuable test completed, Wally reestablished contact with the ground. For two more hours he performed additional control tasks that ended all remaining doubts about man's ability to function in space. Seconds before retrofire to end his mission he radioed, "She's sitting here like a tight rock. She's a good little capsule, I'll clue you." Then the moment came when Sigma 7's retro rockets ignited and Schirra's blazing descent through the atmosphere began.

So accurate were mechanical and human reentry procedures, lookouts aboard the *Kearsarge* first saw the contrail high in the atmosphere. Then a small drogue chute popped open. Awestruck sailors watched Sigma 7 return to earth, swaying gently under its main parachute for the final ten thousand feet. After a flight covering 160,000

miles in nine hours thirteen minutes, it was the best Mercury landing yet, Wally Schirra plopped into the Pacific Ocean only 4 5 miles from the waiting carrier He brought back more than 80 per cent of his fuel but more important, he opened the door for the eighteen orbit Mercury flight which was next planned

'Heck I could have gone eighteen orbits myself,' Schirra said

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Gordon Cooper in Faith 7

WHEN THE NEW YEAR 1963 began Schirra's six orbit flight trailed by a wide margin the multiple orbits of the Russian cosmonauts The previous August Pavel Popovich had circled the earth forty eight times and Andrian Nikolayev spent 94 4 hours in space as he orbited the earth sixty four times The United States obviously needed much more experience in long duration flights Selected to try to more than triple the U S orbital record was a quiet highly independent Oklahoman who enjoyed expressing himself primarily by action not by words Leroy Gordon Cooper loved speed whether in his souped up Sting Ray, his high powered racing boat a jet fighter or a spacecraft circling the earth every ninety minutes NASA officials weren t too fond of his one hundred mph plus speeds on the ground or water

'Gordo' as he was known to his friends was the youngest and least talkative of the Mercury astronauts He hoarded words as though they were dollars Yet his terse comments were often skillfully directed against the sometimes bumbling inefficiency of members of

NASA's dull and humorless higher echelons For this reason, he was not considered by bureaucrats exactly the most fair haired of astronauts A number of people even speculated that his penchant for the barbed dart accounted for his being the last to fly In fact, in the winter of 1963, a persistent rumor was that Alan Shepard — not Cooper — was being considered for the longest U S flight to date When Wally Schirra heard the rumor that Cooper might be denied the last Mercury flight, the pot boiled over Cooper had been Schirra s backup man and there was no doubt in his mind about his qualifications If Cooper didn t get a Mercury flight, Schirra decided, he personally would raise a ruckus in the nation's press Cooper got the assignment

Gordo s fascination with speed and his impatience with NASA s deadly earnest public relations image did not quite fit the astronaut mold officials were trying to construct and maintain When he protested that his duties kept him away from his family too often officials labeled him a complainer When he buzzed the Cape Kennedy launch pad in a jet, they reprimanded him sharply

Far from being a mere "complainer Gordo kept his mouth shut when he worked and concentrated very hard Officials were encouraged by his adeptness in training This fact together with Schirra s previous 'textbook flight caused them to increase the mission of Mercury-Atlas 9 — the last of the one-man flights — from eighteen to twenty two revolutions

The flight that was scheduled for ' more than one day

but less than two days was at first set for May 14 but a simple diesel engine — known as a donkey engine — that was to drive the massive gantry away on its tracks failed to start Later with the count only thirteen minutes from the zero mark word reached Mercury Control from Bermuda that the vital radar needed to track Faith 7 into orbit had broken down As Cooper walked away from the launch pad he grinned and drawled Shucks I was just getting to the real fun part

Nothing stopped him from getting to the fun part the next morning While the countdown continued almost perfectly Gordo prepared himself — to the amazement of everyone in Mercury Control who incredulously watched his breathing rate drop to twelve a minute — by falling asleep in his capsule! He awoke refreshed in time for lift off at 8 04 A M

From their vantage point at the press site more than a thousand newsmen packed shoulder to shoulder under the morning sun watched the brilliant flaming tail of the Atlas pressing its power toward space Even the normally laconic Cooper couldn t restrain his exhilaration as he took the ride of his life

What an afterburner! he shouted to capsule communicator Schirra 'And there goes the tower! Does she take off! Schirra told him 'Seven we re right smack dab in the middle of the plot Then Gordo turned the ship around for his first view of earth What a view! he explained Boy oh boy! And there s the booster! Boy oh boy is it ever close too!

His senses filled with the beauty and adventure of fly

ing through space Gordo settled down to business Like Schirra he soon encountered temperature problems but juggled with control settings until he felt comfortable Reverting to his old unexcitable nature Gordo transmitted frequent status reports that were abbreviated businesslike and almost sounded bored As if to prove that space flight is a snap he took another nap halfway through the second revolution!

Then, crossing the southern United States the astronaut began an experiment to check the visibility of objects in space by ejecting a small sphere carrying two flashing lights But when he turned Faith 7 around, it was nowhere in sight Two hours later on the dark side of the earth Gordo spotted it below him "quite bright quite discernible about ten to twelve miles away" The sighting was important, similar lights would be vital for the rendezvous missions of the future Another experiment however, using a balloon that was to deploy from the capsule and inflate, was a failure Gordo threw the switches but nothing happened

In a third visual test, Gordo looked for a brilliant light turned on near Bloemfontein South Africa He spotted the town first! Anxious for more details ground controllers asked "Would you care to comment on the ground-light experiment?" And with matter of fact brevity, Cooper replied Roger I saw the ground light experiment" The details could wait!

Faith 7 drifted serenely through the night skies of May, setting a new United States record every minute on an endurance run that would surpass the total space flight

time of all five previous Mercury missions Now and then shifting his weightless body in the cramped confines of a contour couch Cooper dozed while alert technicians at NASA sites around the world monitored telemetry signals that revealed the condition of both astronaut and capsule

For long periods during the night no voice contact was attempted But frequently some test pilot s instinct would rouse Cooper from his slumber and he would make a thorough check of his crowded instrument panel For an instant each time he didn t know where he was Then it clicked and the sound of his slow Oklahoma drawl fed into a tape recorder as he read off the vital statistics from dials and gauges Satisfied with the status check, he relaxed sinewy muscles and lapsed back into contented sleep The longest Mercury flight of them all was still strictly routine

'Have a note to be added in for head shrinkers Cooper once drawled into the tape recorder in his Shawnee, Oklahoma accent Enjoy the full drifting flights most of all where you really have the feeling of freedom and you aren t worried about the systems fouling up You have everything turned off and just drifting along lazily Still note that I am thinking very much about returning to earth at the proper time and safely '

Gordon Cooper dozed again only nine hours from discovering how prophetic his comment had been

After twenty nine hours his physical condition continued to be excellent as good after a day of weightlessness as it was on earth He had eaten several meals drunk

water and slept in orbit He had only one strange sensation to report on awakening from his first nap he found his arms floating straight forward sleepwalker-fashion Thereafter he hooked his thumbs under a strap before falling asleep

But the relaxed and routine nature of the flight was to come to an abrupt end Calling the Hawaii station still speaking slowly and calmly, Cooper made a request "Wonder if you would relay to the Cape a little situation I had happen and see what they think on it While turning my warning lights off and back on to dim, my zero point zero five G telelight came on Would you relay to them, and get their idea on it?"

If the little warning light didn't bother Gordo it shook Mercury Control to the core Activated automatically by the first measurable (5 per cent) pull of gravity its screaming message was that Faith 7 was falling out of orbit! Or perhaps someone suggested the light s electrical circuit was faulty Until radar data could be checked nobody knew Then the calibrations came through from Hawaii and California Faith 7 was still in orbit, the electrical circuitry had somehow failed

But more was involved The warning light was part of the autopilot system which normally had the task of positioning the capsule for reentry, then — at the moment the light came on after retrofire — was to put the capsule into a spin which would spread the intense atmospheric heat evenly around the heat shield Somehow the early steps had been bypassed for when Gordo switched on the autopilot, the capsule unaccountably began to spin

The choice was apparent Gordo switched off the autopilot He himself must fire the retro rockets then perform the delicate reentry maneuvers by hand

More trouble yet awaited him Only thirty minutes before retrofire one of the capsule s three electrical inverters went dead The inverters convert battery power to alternating current for operating capsule systems including the instrument panel When the second inverter failed to start Cooper was left with but one And that one was needed for the cabin cooling system during reentry With automatic reference instruments gone Gordo faced a manual reentry completely on his own

Waiting on a tracking ship in the Pacific Ocean far below John Glenn ran through the procedures with Gordo As the moment approached Gordo lined up marks on his window with the horizon and with the proper stars "Right on the gazoo ' he calmly told Glenn Then Glenn counted down to zero and Cooper started home After the retro rockets fired Glenn asked if the capsule positioning held all right to which Cooper lazily replied, Well pretty fine

No one could doubt Cooper s opinion or his skill when Faith 7 appeared minutes later under its red and white parachute only four miles off the bow of the *Kearsarge* In an unprecedented manual return from orbit the youngest astronaut trimmed eight hundred yards off the accuracy of Wally Schirra s landing after chalking up thirty four hours twenty minutes in space during twenty two revolutions of the earth

It was a fitting last flight for Project Mercury

16

The Unmanned Explorers

§ Ranger

In a historic sense the space feats most worth chronicling are those involving men, and those being done for the first time. As advanced missions are accomplished their historical importance declines to the point where they become routine even though they may be far more meaningful or complex than earlier, more famous steps into space. Our technology is such that we have come to expect such progress, actually to demand it.

So it is that only the eye-opening dramas are deemed worth of more than passing notice in a short history of space flight. In the years beginning with 1962, it was no longer enough to attempt to orbit a satellite. It was not even enough to succeed for the successes were too many, outnumbering failures fifty two to seven in 1962, thirty seven to eight in 1963, fifty-four to five in 1964.

Weather satellites, one of the most important advances made possible by the age of space, are a case in point. The drama of viewing weather pictures covering thousands of square miles of earth became the routine of pro-

fessional meteorologists as Tiros ran its perfect record to eight Precision plotting of weather patterns ranging from fleecy lines of clouds to the eyes of powerful hurricanes made it possible for the Weather Bureau to change its long standing format for forecasts from possibility of rain tomorrow to the more accurate thirty per cent [or sixty per cent or ninety per cent] chance of rain tomorrow But crowds no longer gathered for Tiros launchings Nor did the stories often reach a newspaper s front page

For a different reason little was heard about the many Air Force projects in space With the advent of success strictest security closed mouths and doors Yet bigger and better Discoverer satellites — many carrying data capsules for later recovery — orbited the earth in increasing numbers until at last, after Discoverer XXXVIII, the Air Force even stopped naming them Thereafter only terse announcements that a classified payload went into orbit today gave word that the pads at Vandenberg Air Force Base still were active There were twenty-nine such announcements in 1962 alone and not all of them were Discoverers While the nation applauded Mercury Ranger and Mariner, the United States Air Force quietly established its own beachhead in space and began to build an efficient network of surveillance satellites

The long lull in manned space flights — from Gordon Cooper s Mercury mission in May of 1963 to the two man Gemini flight of Gus Grissom and John Young in March of 1965 — was not without its moments of adven

ture Such moments were an integral part of the Ranger program

Ranger had its beginnings at the turn of the decade In accordance with President Kennedy's national goal of landing men on the moon before 1970, its efforts were to be aimed at high altitude photography of the lunar surface Under the supervision of the National Aeronautics and Space Administration management of Ranger passed into the hands of the Jet Propulsion Laboratory at Pasadena California JPL is unique among the agencies and industries concerned with space It is nonprofit, educational and research oriented Though JPL itself is a satellite of the University of California, it is financed in part by the federal government At its head sits Dr William Pickering considered to be one of the most brilliant of Americans in the fledgling science of space exploration Under his direction Ranger grew and flew

The growing period was slow Often it was painful At times it seemed inconceivable that Ranger s engineers and designers could find the energy to return one more time to their drawing boards Ranger I sat ready on the pad at Cape Canaveral in August 1961 Like the second Ranger s in the series, its mission was not to impact on the moon but to hurtle past it on the way to a deep space orbit for further research into the makeup of the cosmos Rocket power for Ranger was to come from a modified Atlas intercontinental ballistic missile the same rocket used in orbital Mercury flights But the strength of Atlas was limited To break free of an orbit around the earth

requires a speed of more than twenty five thousand miles per hour It would come from the powerful thrust of an Agena rocket often used as a second stage for the Atlas

Launch day came on August 23 Cascading sheets of water used to cool the blast deflectors still steamed long after Atlas Agena and Ranger disappeared into the sky For a while it looked perfect Then word came back from radar tracking sites Only 313 miles above the earth Ranger stopped climbing and arced back into an egg shaped orbit around the earth Seven days later it was consumed in the atmosphere A chill November breeze blew in from the Atlantic Ocean as Ranger II met a nearly identical fate This time it reached an altitude of only 147 miles after the Agena apparently failed to ignite Before the day was over Ranger II disappeared in a fiery ball streaking downward toward earth

Shaken but not beaten engineers prepared for Ranger III In the first two failures the cause was attributed to malfunctions in the Agena The Ranger satellites themselves were still only passengers They lost their chance to prove themselves before their part of the mission had even begun Also lost and this was to become painfully apparent was the chance to see how Ranger's complex systems worked under the conditions of space flight Now there would be no more trial runs Ranger III's target was the moon

To accomplish its photographic mission Ranger III was increased in complexity and weight Its medium resolution television cameras and sixty watt transmitters

were designed to relay pictures to JPL's Deep Space Network during the final ten minutes of approach Because it could not carry the heavy retro rockets necessary to actually land on the moon, Ranger would be shattered on impact Theories varied on the nature of the lunar surface ranging from guesses at an earthlike surface to a surface smothered in a mile-deep layer of dust

In an attempt to solve the riddle, another major device was incorporated into Ranger III It was a seismometer — a sensitive instrument used to measure shock waves — completely enclosed in a balsawood capsule It was to be ejected from Ranger III seconds before the crash Whatever it encountered — a soft layer of dust weak and porous rock, or solid stone — would briefly trigger the seismometer and relay its momentary message through Ranger back to earth

As the waiting moon moved through its eternal cycle JPL scientists chose January 26 1962, as their day to shoot The Atlas-Agena combination again went through the lengthy countdown while reporters photographers and television cameramen shivered on the press site nine thousand feet away "There s a charm someone said to nobody in particular as ignition occurred Then Ranger III was on its way To the thousands of eager engineers administrators and reporters waiting behind it seemed that everything was going perfectly A critical point was passed when Ranger III broke free of the earth s gravity, the first of its kind to get that far But hours later discouraged officials revealed that their calcu-

lations showed that the satellite was traveling too fast Two days later it passed 22 862 miles in front of the moon on its way to an eternal orbit of the sun

The flight was far from a total loss Ranger s own complex systems had worked generally as planned and no time was wasted in preparing for another try It came on April 23 Again an Atlas rocket put the Agena with its Ranger payload into a parking orbit over the earth And again the Agena fired up on time to break toward the moon This time the trajectory was nearly perfect With small midcourse corrections Ranger could be brought in right on target But then something happened again A small timer mechanism inside Ranger failed to turn on There was no way to control the satellite or any of its experiments The only consolation was the excellent aim Even without midcourse corrections Ranger skimmed over the visible edge of the moon was pulled around by lunar gravity and crashed to the surface on the side never seen by man Though none of its experiments could be activated Ranger IV went into history as the first United States spacecraft to reach the moon

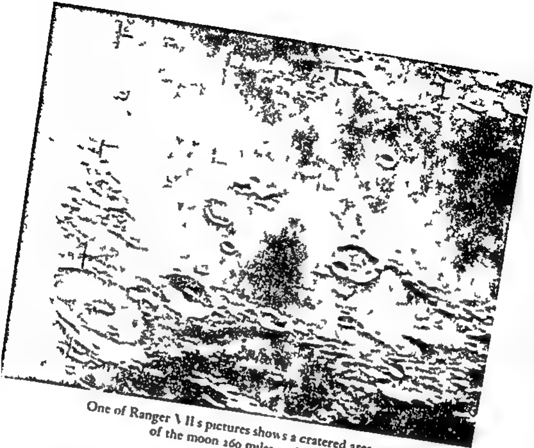
Ranger V, launched six months later on October 18 did not do even that well Its solar cells failed to provide electrical power during the journey and only eight hours forty four minutes after lift-off its batteries went dead Unable to perform a midcourse maneuver Ranger V missed the moon by 450 miles It was to be more than fifteen months before another try would be made

In the intervening time Ranger underwent more changes Five of its original fourteen missions were can

celed, putting even more emphasis on the need for success in the four remaining flights A high resolution television camera replaced the encased seismometer capsule ending for the time being chances to get surface measurements from the moon Six cameras went into the Ranger package two for wide angle coverage and four with narrow angle lenses A pair of transmitters would begin relaying pictures only nine hundred miles above the moon if all went well But they didn t Ranger VI was launched on January 30 1964, and reached its lunar target sixty-five hours later In the final critical minutes, none of the television cameras worked Now only three chances remained

With the lessons of Ranger VI firmly in mind engineers set to work modifying the circuits responsible for turning on the cameras and relaying their photos As a further precaution increased care was taken in controlling temperatures and in fitting the vital components into the Ranger shell By late July, the team from JPL was ready to try again

The years of frustration the days of agony that had marked Ranger's first six flights fell away to be buried in the jubilation that came with 'Lucky Seven' With the precision of veterans the space team put Ranger on course to the moon Even without a midcourse correction, it would get there But the scientists called for a small correction anyway, to bring Ranger in on an exact spot in the Sea of Clouds Thousands of miles from earth the robotlike satellite obediently switched over to an omnidirectional antenna folded its directional antenna



One of Ranger VII's pictures shows a cratered area of the moon 260 miles wide

out of the thrust path of its small rocket twisted and aimed itself by sighting on the sun and the star Canopus then fired its motor to change course Radio signals said that all was well

Sixty eight hours out of the Cape Ranger VII zeroed in for the first close up portraits of the moon ever taken At 1120 miles its camera clicked on and for the next seventeen minutes awestruck earthmen stared at

the moon while 4308 high-quality pictures flashed back More than four hundred square miles were covered by the first of them And the last showed an area only sixty by one hundred feet, with yard wide craters only one foot deep clearly visible

This is a great day for science" said Dr Gerard P Kuiper of the University of Arizona s Lunar and Planetary Laboratory This clearly implies that we are not dealing here with enormous layers of dust The new region of knowledge is in a true sense an extension of the earlier knowledge'

The last sequence of still pictures — those closest to the moon — were so arranged on movie film that witnesses in a theater had the startling impression of coming down in a somewhat jerky but highly realistic manner to the actual surface of the moon At Houston when the astronauts were assembled to view the film, Wally Schirra could stand the suspense of a seemingly imminent crash no longer Bail out you fool!" he shouted out in the theater as the rest of the astronauts roared with laughter

The two remaining flights in the Ranger program were even better Ranger VIII was launched February 17, 1965 on a mapping mission that relayed back 7137 photos as it followed a slanting approach to the Sea of Tranquility Before it crashed into the lunar plain just fifteen miles from the aiming point, Ranger VIII added detailed coverage down to five feet over a 900 000 square mile area to our growing files on the moon

Just one month later Ranger IX followed It was

aimed for a spot inside the crater Alphonsus, and its cameras were aligned in a final maneuver to point directly along its path of descent They were triggered 1400 miles above the surface, responding instantly with a high altitude look at the pockmarked moon More than two hundred of the ensuing pictures went out over regular television networks and millions of viewers tingled with excitement at the words on their screen LIVE FROM THE MOON

In the most spectacular one of them all Ranger IX gave the world nearly 6000 more pictures, some showing details as small as ten inches Now the Ranger program was over More than enough pictures had been relayed to earth to make several astronaut landing site selections And scientists already had an abundance of new data on the nature of the lunar surface Ranger s legacy was knowledge its challenge was the future

§ ComSat

As the national effort toward probing the moon drove forward another group of Americans plunged into a project that was to reach and touch each of us in our everyday lives In mid 1962, private industry took the first step toward the establishment of commercial rights in space With the help of NASA a privately owned satellite named Telstar soared into orbit from the launch pads at Cape Canaveral The thirty five inch sphere was packed with communications receivers and transmitters as well as numerous instruments for recording additional

data about space Its 3600 solar cells pumped power into nineteen nickel cadmium batteries, assuring a continuous supply of power as it circled the world every two and one half hours

Telstar was developed and owned by the American Telephone and Telegraph Corporation, whose officials wisely foresaw the value of space satellites to their industry Already the undersea cables that carried conversations and messages between continents were overloaded They were subject to the vagaries of ocean storms that could uproot them and to the possible maraudings of unknown denizens of the depths A broken cable disrupted or delayed communication for indefinite periods and repair work was not only slow but costly With Telstar AT&T showed the world a new wav

The historic satellite, operating at altitudes up to 3500 miles received signals flashed to it from earth then re layed them instantly to waiting receivers thousands of miles away Television viewers on both sides of the Atlantic sat enthralled as they watched live television broadcasts from England and France Even telephone conversations were relayed through the orbiting satellite The success of Telstar gave the last needed push to a bill even then pending before Congress

On August 31, 1962 President Kennedy signed the bill creating the Communcations Satellite Corporation Although it was formed by the government, ComSat was a private company Thousands of individuals owned one or more shares of its stock Its Early Bird satellites first

launched in 1965 were the more sophisticated descendants of Telstar, the forerunners of communications satellites to come

By 1965 the United States had become so prolific in space launches that it seemed there could be nothing remaining to excite the imagination before we reached the moon itself Instead 1965 emerged chiefly through the *string of successful Gemini flights* as the *most brilliant* year to date And even as the new year began a small satellite named Mariner IV was hurtling somewhere in space temporarily forgotten by the public but still on course for a fateful date with another world

§ MARINER

Mariner IV began its trek in 1964 on November 28 atop an Atlas-Agena rocket that tore it free of the Cape Kennedy sand and aimed it like a bullet to intercept the mysterious planet Mars a flight distance of more than 134 million miles Twenty-three days earlier Mariner III had begun a similar journey but became useless when its protective shroud did not deploy With Mariner IV everything worked as planned

The journey to Mars was to take 228 days Then if the aim was right Mariner IV would skim across Mars only six thousand miles from the surface taking twenty one television pictures of the planet below and returning data on such things as its atmosphere and temperature With the July 14 encounter date less than a month away the National Aeronautics and Space Administration made this statement on June 20

"After two hundred and four days of the longest space exploration mission in history Mariner IV's electronic signals to earth today are arriving with a strength of slightly less than one billionth of one billionth of a watt Mariner will fly another four weeks before passing within six thousand miles of Mars July 14 for close up measurements, and it has many weeks to go beyond Mars for transmission of television pictures and other scientific data back to earth Latest event monitored in near real time was a command issued by Mariner's on board central computer and sequencer to the Canopus star tracker June 14 It is necessary to keep this star sensor pointed at Canopus so that the spacecraft will be properly aligned and stabilized in that attitude

On the evening of July 14 the awaited event occurred Mariner IV passing less than six thousand miles above the Red Planet began its long range photographic mission As the days passed and more and more pictures were slowly transmitted over distances up to 150 million miles from earth the first true picture of Mars began to take form It showed a moonlike planet pocked with craters and, except for polar ice caps devoid of water No oceans rivers or lakes appeared No forests or plains could be seen The moonlike planet seemed very old and very dead

Professor Bruce C Murray a geologist from the California Institute of Technology described one of the pictures showing little more than a crater

It's roughly seventy five miles across There is for

instance a small crater here that is about three miles across and intermediate craters of all sizes within it The implication to people who have studied the moon s very large craters is they must be very ancient because the impact on the planet of a body that could produce a crater that size must be very infrequent The surface itself since it has these features on it must be two to five billion years old a very ancient surface indeed

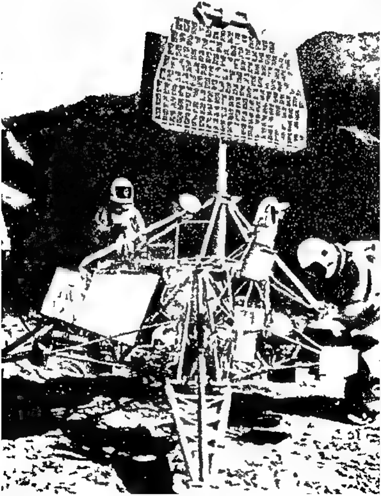
In all of the pictures, nothing that hinted of intelligent life could be seen

I think we can safely be quoted we can see no man made features on Mars Dr Murray said "May I also remind you the same kind of camera photographing the earth from an equivalent altitude would see nothing man made on earth with very few exceptions

Thus the answer to that one question at least remained out of our grasp In the meantime, Mariner IV continues on a wide circuit through the solar system At its furthest distance from earth some 16 million miles the plucky little satellite operated and on May 21 1965 nearly a year after passing Mars NASA reported that telemetry signals were still being received On its course around the sun Mariner reported additional data on space phenomena and its radios and instruments operated efficiently long after their anticipated lifetime

§ Surveyor

The second major milestone of the middle sixties had the most direct possible effect on the race to put men on the moon In Project Surveyor the nation was aiming



for a robotlike spacecraft which would land gently on the moon then swivel its camera about to photograph the surrounding area In addition complex instruments and probes would transmit on the spot readings of temperature, radiation, surface hardness, depth of the dust layer and possibly on later flights even a chemical analysis of the soil Although it came nearly three years behind schedule the flight of Surveyor I was unmatched in excitement as the nation tuned in and symbolically became a part of the actual landing

Surveyor I was launched on May 30, 1966 Sixty three hours later, it entered the final descent to the moon From Surveyor Operations at the Jet Propulsion Laboratory in Pasadena California moment to moment descriptions followed it down At the critical instant the vernier rockets were fired to stabilize Surveyor and a large retro rocket ignited to slow its five thousand miles per hour speed

Ten seconds, waiting for the marking radar Five, four three two one mark Vernier ignition retro is now firing Ignition looks stable We are now at 5148 miles an hour Down to 116 000 feet [above the moon] 4590 [mph] Now down to 63 000 feet 3900 miles per hour We are now at 30 000 feet retro burnout is confirmed

Now only the vernier rockets burned thrusting downward to slow Surveyor for its final gentle drop to the surface The critical number was thirteen for when the speed slowed to thirteen feet per second, the vernier rockets would shut down and Surveyor would drop the

remaining few feet to the surface If all went well its spidery legs and saucer shaped feet with their honeycombed aluminum centers would absorb any shock The honeycomb could even be crushed as an additional measure to take up any unexpected pressures Now the big gest questions were Will it land softly enough? And if it does, will it sink out of sight in a bottomless layer of dust? The answers were only seconds away The commentary resumed

"Four hundred feet per second vertical velocity 28,000 feet [altitude] 24,000 feet We are in lock with the engineering pre-data strain gauges are reading out These strain gauges will give specifica tions about touchdown 12 000 feet 10 000 feet, all signals are normal 8000 feet, 250 feet per second [speed] 200 feet per second Surveyor is reported in excellent condition all signals look good 4000 feet stable 1000-foot mark, 800 feet 600 feet, 400 feet 200 feet, 100 feet 13 feet per second speed TOUCHDOWN!"

The jubilant voice was drowned out by the cheers at JPL and probably by the cheers echoing across the land A United States satellite was safely and softly resting on the moon In moments it would begin transmitting photographs The voice came again even as the picture appeared on television screens everywhere

We are receiving the picture! Video is being received now coming through! Pictures are coming through!

Come through they did! Throughout the night, and

Surveyor I s pictures show a moon rock
about six inches high and eighteen inches long

over the next weeks, Surveyor sent thousands of clear and sharp pictures of everything its camera could see One particularly clear photo showed the craft's own footpad It had landed so softly that the crushable aluminum center was not even dented! And the pad itself sank only one inch into a dusty layer before coming to rest on the hard, true lunar surface There was no doubt remaining that man could not only land on the moon he could also safely walk about on a reasonably firm surface

With the success of the Surveyor series, the United States had taken another long stride toward reaching the moon More Surveyors would land on other sites before the prime spot would be chosen for the landing of astronauts Another spacecraft called Lunar Orbiter was put into an orbit of its own around the moon to map the entire equatorial area with its high-resolution cameras so powerful that they could even pick up the image of a lonely Surveyor sitting quietly on the cratered surface below And around the earth, satellite after satellite continued its task of weather observation, communications or scientific research

Man built them and controlled them but it was not necessary that man himself, be inside a growing family of probes and satellites

17

Project Gemini

THE STORY OF GEMINI, like that of Mercury, is the story of a learning curve. In Gemini's case, the curve began where Mercury ended, then arced upwards so rapidly that most flights far exceeded original expectations. So fast was the reaction to Gemini's lessons that no mistake repeated itself; this meant that each success brought heavier and heavier demands on the flights that followed. It was no longer necessary to run duplicate missions as Grissom followed Shepard and as Carpenter matched Glenn. Instead, even failures became building blocks for ambitious Gemini missions that often bore little resemblance to the meticulous flight plans laid out in advance.

The differences between Mercury and the two-man Gemini are something like the differences between floating in a basket under a hot-air balloon and piloting an airplane. Though both fly through the air, the second is far more versatile and demands a new degree of skill from its pilot. The balloon pilot is little more than a passenger subject to winds for his direction and speed, but the airplane pilot is a commander, modifying his craft's

direction, speed and altitude by his deft manipulation of the controls

So it is with space flight The pioneer astronauts who circled the earth in Project Mercury were little more than passengers Once their Atlas booster put them into space, only one change could be made in their orbit retrofire to return them to the seas below In the fly by-wire mode an astronaut could control his capsule to the extent of pointing its nose in a given direction But the capsule itself would continue racing through space heedless of whether it did so frontwards, backwards sideways or upside down The orbit could not be raised, it could not be moved sideways (out of plane), it could not be lowered, except for reentry Mercury was a 'capsule and that was what it was intended to be But to apply the word capsule to Gemini is a misnomer Gemini was a spacecraft

Gemini got its name from the constellation containing the bright twin stars Castor and Pollux and it is an appropriate designation for a highly complex twin seater spacecraft More than twice as heavy as Mercury, its weight ran up to 8400 pounds on some flights To house all the necessary equipment, oxygen and fuel for extended flights, Gemini was composed of three sections The front section resembled Mercury although it was much larger In this section was the sealed cabin with crowded seats for two astronauts Panels of instruments and switches faced the crew, covering the interior walls from the command pilot's left elbow to his partner s right elbow Under the panel ahead of the command

pilot, neatly folded away when not in use was the push pull lever that helped give Gemini the type of mobility impossible in Mercury At the astronaut s touch the control lever fired rocket thrusters built into Gemini so that its orbit could be changed at will A duplicate controller folded out from the right hand wall for use by the other astronaut On a center console easily reached by both astronauts was a control stick for changing or maintaining the spacecraft attitude A small window ahead of each seat allowed forward visibility and inside of the cylindrical nose were parachutes radar and sixteen independent thrusters for controlling Gemini during reentry With those astronauts could aim their spacecraft toward any point within a footprint 150 miles long and forty miles wide It would even be possible to adjust their trajectory if their small on board computer told them that they would land too far from the waiting ships

Only the forward section returned to earth Behind it a pair of cylindrical adapter sections held items which were only necessary for actual orbital flight The first directly behind the cabin held the four powerful retro rockets and their fuel supply The entire section would be jettisoned after the rockets were fired The second section to be jettisoned several minutes before retrofire contained thrusters fuel electrical power and all the necessary items for sustaining the astronauts and their craft in space for periods up to two full weeks

A mightier rocket than the Atlas was needed to push a heavyweight spacecraft like Gemini into orbit Chosen for the task was the Titan 2 a modified ICBM Its count-

down period was hours shorter than the Atlas, and the astronauts need enter their spacecraft only ninety minutes before lift-off In addition, Titan 2 had an automatic malfunction detection system to turn the 400,000-pound thrust engines off if anything went wrong during the 3 7 seconds between ignition and lift-off This unique safety factor was to become critical at Gemini's midpoint

Of the twelve flights planned for the Gemini program only the first two were unmanned On April 8 1964 just one year and six days after NASA signed a contract with McDonnell Aircraft Corporation to build the spacecraft Gemini I went into space The flight tested both the aerodynamic effects of the spacecraft racing upwards through the atmosphere and its compatibility with the Titan 2 booster The mission was a complete success

Five days later, at a hastily called press conference in the newly opened auditorium of the Manned Spacecraft Center in Houston Dr Robert R Gilruth MSC director, introduced the crew that would fly the first manned Gemini mission On the stage grinning from ear to ear, sat Gus Grissom and boyish looking John Young, from Orlando Florida, one of the nine new 'second generation astronauts Their flight which was to be Gemini III would take place in November or December, and in it they would attempt to circle the earth three times to test out the equipment and procedures that would become standard Asked what he thought would be the most difficult part of the flight, Grissom quickly replied 'The part between lift-off and landing' The quip was typical of the taciturn astronaut whose relationship to

Virgil Grissom and John Young (*standing*) during training operations in the Gulf of Mexico

the press had rapidly chilled after he felt he had been unfairly blamed by some reporters for the accidental loss of his Liberty Bell 7 capsule Several years were to pass before Grissom and the press again reached cordial terms In the meantime he proved his skill with intense training and study

Before Grissom and Young could fly one critical flight test remained First scheduled for August 1964 Gemini I would loft a spacecraft high above the atmosphere, then ram it back in a high speed reentry to prove out its heat shield s ability to protect astronauts But as the long muggy summer dragged on problem after problem delayed launch day It was not until December that pad crews and spacecraft engineers were ready to let Gemini II go

Crowds of newsmen gathered at the press site in the early morning hours of December 9, among them veterans from the Mercury days and newcomers waiting for their first lift off Instead they witnessed something without precedent in the history of the Cape Jim Schefter then covering for the *Houston Chronicle*, reported it this way

> The Titan rocket belched smoke and went nowhere Clouds of orange smoke spouted from the rocket s engines at 10 41 A M But the big white bird just sat there It fizzled like a broken sparkler

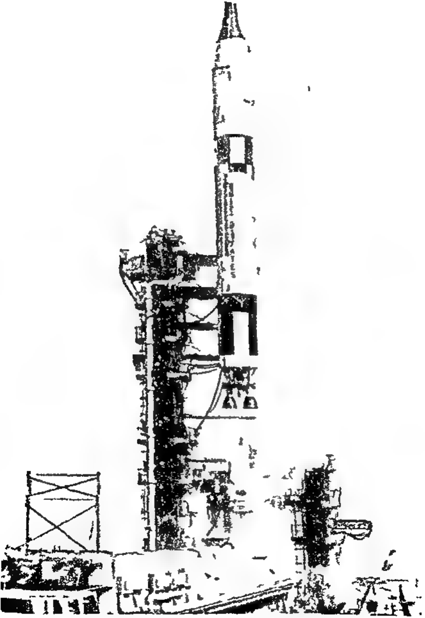
In the confusion of the moment nobody knew what had happened The rocket started but it didn t lift off Nor did it explode as had such rockets as the Atlas before it One radio announcer was already describing the

lift off when he realized that something was wrong With questionable ingenuity he brought it back to the pad

'There's lift-off he breathlessly told his audience "No! Four giant arms are grabbing the rocket and hauling it back!"

Later after a calm inspection of the rocket had been made, the answer was found to be simple A leaky hydraulic line bled off pressure holding one of the two main rocket nozzles in place When the engine started the nozzle tilted slightly A signal from the malfunction detection system turned off the fuel and the rocket shut down after less than 1 7 seconds of firing Had the system not worked the Titan would have been destroyed after lift off by the effects of the tilted nozzle Damage instead was limited to a crack in the nozzle itself Five weeks later after repairs Gemini II roared out over the Atlantic to an altitude of ninety nine miles It successfully reentered and was recovered intact by a waiting ship The scene was set for man to take his next step into space

When Gus Grissom and John Young took the elevator ride to their waiting spacecraft on the morning of March 23 it had been more than twenty two months since Gordon Cooper's flight had ended the Mercury program Some referred to the long delay as 'the year of the quiet moon Now climbing into the first spacecraft that would actually maneuver and respond to a pilot's touch the astronauts were ready to prove that man could be more *than just a passenger during the weightless ride*



Grissom and Young lift off for the first
Gemini flight propelled by a Titan missile

through space Only a month before launch day Gus had repeatedly emphasized 'This is an engineering test flight We're going to see how things work

In the nearly five hours between lift off and recovery — what Grissom called the hardest part — the two astronauts saw that Gemini worked very well indeed Their initial orbit ranged from an apogee (high point) of 140 miles to a perigee (low point) of 100 miles They didn't wait long to change it Over Texas on the first revolution Grissom unfolded his maneuver lever from beneath the instrument panel Then after casually swinging the entire spacecraft around so that its heavy one hundred pound thrusters pointed toward Florida he shoved the lever forward Both astronauts could plainly hear the clattering roar of the rockets firing somewhere behind their backs After seventy four seconds Grissom released the lever and all was quiet Already radar sites across the southern United States were feeding information to computers in Florida Maryland and Texas In minutes the word was flashed to Grissom and Young they had successfully changed their orbit exactly as planned to a nearly circular path of 105 by 98 miles Halfway again around the world the astronaut twins prepared for their major orbit change This time they would move their orbit not up and down but sideways by more than a mile With small bursts from his attitude control thrusters Grissom swung the spacecraft nose around ninety degrees from east to north Then for fifteen seconds he fired up the heavy thrusters again If later Gemini crews were to successfully rendezvous with

other objects in space this maneuver must work! And ground radar showed that it did Grissom and Young had briefly overcome the momentum of their 17,000 miles per hour forward speed to jog sideways through space

Now only one test remained — a precaution against the possibility of the retro rockets failing to work Grissom fired one long burst from his heavy thrusters, dropping the perigee of Gemini III to a record low of fifty-two miles Now the gravity pull of earth and the drag effects of the upper atmosphere would bring them home even without retro rockets As they soared over the South Pacific Grissom and Young went through their final checklists When their on-board clock reached zero, Grissom punched the button that ignited the retros Thirty-five minutes later, astronauts Gus Grissom and John Young bobbed in the Atlantic just over fifty miles from the aircraft carrier *Intrepid* The shortest of all Gemini flights was over and the way was clear for the giant strides already being planned for the months ahead

Not one but two new faces peered out from space helmets for the flight of Gemini IV Rookie astronauts James McDivitt of Jackson, Michigan and Edward White of San Antonio, Texas, climaxing nearly eleven months of intense training rode their Titan 2 rocket into space on June 3 to begin a mission so daring that it brought more than a thousand newsmen to Houston filling every niche of the new two story office building across the street from the Manned Spacecraft Center that served as the press center Across that four lane street in a tall windowless wing of the most tightly secured build-

ing at MSC, the nerve center of manned space flight

For the first time on Gemini IV the new $130 000 000 Mission Control Center took full command The familiar Mercury Control at Cape Kennedy had ended its active service to astronauts with the splashdown of Gemini III Countdown and launch control, of course remained in the Cape s blockhouse But with the instant of lift off all responsibility shifted more than nine hundred miles west, to the dimly lit supercomplex mission operations control room (MOCR) in Houston In the third floor room highly skilled engineers sat at their consoles watching the dials gauges and computer operated television displays that instantly revealed the condition of astronauts, spacecraft and rocket On the floors below the world s biggest computers whirred and clicked continually receiving analyzing and reporting new information to the control team Through a worldwide system of cables and radio transmitters data flowed into Houston from special sites as far away as Africa and Australia and even from tracking ships positioned far from land in the Pacific and Atlantic One of the consoles was manned around the clock by a public affairs officer whose frequent reports were piped to loudspeakers and closed circuit television sets for the newsmen jamming the press center

The action filled flight of Gemini IV marked the beginning of a routine that would be followed on all other missions From the Cape Kennedy blockhouse the voice of Jack King carried the last few seconds of countdown to Houston And as flame spurted from the Titan s tail

the image flashed on MSC's and the nation's, TV monitors it was Paul Haney's voice, from the Houston control center, that signaled the shift of command "Lift-off We have a lift off climbing very nicely "

Six minutes later, more than five hundred miles out across the Atlantic and one hundred miles high Jim McDivitt fired the Gemini thrusters to pull away from the Titan second stage In a matter of seconds, they were free As McDivitt swung the craft around, he and Ed White were treated to a marvelous sight Before their eyes glistening in the sunlight and slowly beginning to tumble, was the Titan main stage For the next thirty minutes according to plan, McDivitt worked his throttle in the first attempt ever made to fly alongside another orbiting object and inspect it The unexpected lessons learned in that brief period became a vital key to future missions For instead of closing the gap, McDivitt and White saw it widen as the booster moved away Again and again, he pointed toward the booster and fired the thrusters But to his frustration, the gap widened still more

"The booster fell away pretty rapidly and got below us," he reported to the ground "I have been struggling here to not let it get too far from me '

Apparently, flying in space involved problems different from flying an airplane Later, the computers found the answer By thrusting forward McDivitt had increased the spacecraft's speed Under the physical laws of space this increased the altitude of its orbit putting the booster below them and ahead of them Another

thrust, more altitude and the booster was even farther below and ahead. To catch it would have required backward thrust. But a pilot's training alone doesn't prepare him for such a complex maneuver. The experience was vital for the rendezvous missions ahead. As their fuel supply sank lower, McDivitt ended the test.

A more important job lay just ahead. Ed White felt the excitement while he and Jim carefully went through a lengthy checklist item by item. For months, Ed had pushed his lean and tough body to near its limits with a grueling regime of exercise to prepare for this moment. Mile after mile of daily running added strength to his legs. A forty-foot rope hung from a backyard tree became child's play for his arms and hands as he climbed up and down. A one-hundred-pound weight held at arm's length brought no quiver to his muscles. He was ready for a journey attempted only once before, by a Russian less than three months earlier. Paul Haney's voice suggested subdued emotion when, as Gemini IV neared Hawaii on the third revolution, he announced:

"White has opened the door. He has stood up. McDivitt reports that White is standing in the seat."

An American astronaut, traveling more than 17,000 miles per hour in the airless void one hundred miles above the earth, was about to step out into space! For the next twenty minutes, on a space walk from Hawaii to Bermuda, Ed White would have only his pressurized space suit, a thin umbilical and an emergency back pack to supply him with oxygen and protect him from the abso-

lute vacuum he had entered A small propulsion gun, firing jets of compressed oxygen, would give him maneuverability until its tank ran dry Now with the moment at hand, the crowded press center was totally silent Many reporters held telephones to their ears the line already open to a waiting news desk For long taut minutes, with Gemini IV out of contact between Hawaii and California, no one spoke Then Paul Haney s voice boomed from the speakers

'Gus Grissom has just established contact with the spacecraft McDivitt confirmed that White did leave the spacecraft He said he looks great Jim is quite exuberant about the performance that he s witnessing at this time Let s cut in live now and listen to what White says"

"Okay Ed, they re receiving us' McDivitt shouted gleefully Tell 'em what you think'

From the end of his twenty five-foot lifeline, Ed White's excited voice came through

"This maneuvering unit is good he radioed "The only problem I have is that I haven't got enough fuel

I m looking right down and it looks like we re coming up on the coast of California There is absolutely no disorientation "

'One thing about it' McDivitt cut in 'when Ed gets out there and starts whipping around it sure makes the spacecraft tough to control

"Is he taking pictures? Grissom asked

'Of the ocean" said McDivitt 'This is only my guess

'Take some pictures " Grissom ordered

"Get out in front where I can see you again," McDivitt called to Ed White

"Okay "

"Where are you?"

' Right out in front now I don t have the control I had any more '

Like a man shaped balloon drifting on a gentle breeze Ed White floated up into range of McDivitt s camera

' Hey Ed smile!

I m looking right down your gun barrel huh? All right '

In a playful mood White reached out and rapped on McDivitt's window

"Hey! You smeared up my windshield, you dirty dog! You see how it s all smeared up there? '

' Yep

Coming over Texas, the astronauts looked directly down on the area where their families waited and listened to their voices from space

"We re looking right down on Houston,' White called

Go on out and look " quipped McDivitt to Gus Grissom ' Yeah, that's Galveston Bay right there Hey Ed, can you see it ?

But now the space walk scheduled for ten minutes had lasted more than fifteen When Grissom radioed "Get back in,' a dialogue began that sounded like two boys frolicking in a newly discovered swimming hole

Okay said McDivitt then called to White They want you to come back in now

This is fun

Well back in Come on

I m coming

Okay Whoops take it easy now

Aren t you going to hold my hand

No come on in here

It s the saddest moment of my life

Well you re going to find it sadder when we have to come down with this whole thing

Nearly four days later that final moment came when Gemini IV splashed down in the Atlantic after sixty two revolutions of the earth McDivitt and White had added a new dimension to American space missions by nearly tripling Gordon Cooper s thirty four hours in orbit and multiplying Gemini s first three revolution mission by more than twenty Yet even as they landed preparations were well under way at both Houston and Cape Kennedy to double the record again

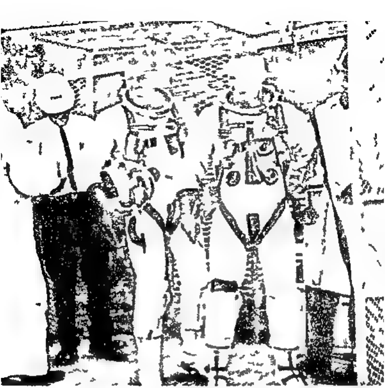
One critical advancement in the state of technology made it possible to aim for space flights longer than four days This was the fuel cell a magical piece of engineering that produced electricity out of the combination of hydrogen and oxygen Even the best of batteries are limited for space use because there is no way to recharge them as their power supply dwindles But with a fuel cell electricity is produced in a steady flow until its oxygen and hydrogen tanks are empty As a side benefit, the entire system weighs far less than equivalent battery

power and still better, produces a by-product of water that will on advanced fuel cells be pure enough to drink

For the eight day flight of Gemini V Gordon Cooper and his ebullient partner Charles Pete Conrad would rely on the cells for their electrical power They also had an important task in perfecting the techniques needed for rendezvous In their adapter section they carried a strange looking new device called a rendezvous evaluation pod (REP) The seventy six pound package contained radar and flashing lights identical to those planned for use on Agena target vehicles The REP would be ejected then allowed to drift miles away before Gordon and Pete tried to catch it on a chase through space

They never got the chance Midway through their first revolution on the morning of August 21 1965, an emergency signal flashed on their panel Called a Delta P light it warned that pressure was dropping rapidly in their fuel cell system Without adequate pressure the cell wouldn t work In the Mission Control Center in Houston engineers feverishly worked to find an answer while flight director Chris Kraft held his decision on whether or not to end the flight on the first day instead of the eighth Within an hour controller Dick Glover reported that a dead heater used to warm the liquid hydrogen and oxygen was the villain But he added the pressure was likely to stabilize and then begin to rise slowly Kraft snapped the order Go

Then hours later according to prediction the cells settled into a stable state Their output of power however



Gordon Cooper (*left*) and Charles Conrad on their way up the gantry during a simulated mission

was vastly reduced and the rendezvous exercise was canceled From day to day, as the ground watched, their output gradually increased It was even possible to perform a "phantom rendezvous with Cooper and Conrad maneuvering their spacecraft to a precise spot in the sky chosen by the controllers The REP was long gone, but the phantom showed the way for the extraordinary missions to come

Cooper and Conrad went all the way. Drifting beneath their billowing parachute after reentry the astronauts had logged nearly 191 hours in space — completing 128 revolutions of the earth in eight days. Along the way they set new records for space flight duration and for the first time since Yuri Gagarin's flight in 1961 put the United States ahead of Russia in gathering manned experience in orbit.

18

Halfway to the Moon

WE HAVE A LIFT-OFF"

The excited voice of Paul Haney on the morning of October 25, 1965, signaled the beginning of what was scheduled to be one of the greatest of all Gemini missions The lift off was a mighty Atlas mainstay of Project Mercury, but now carrying an Agena target rocket upwards toward space From their spacecraft at the nearby Gemini pad Wally Schirra and Thomas P Stafford couldn t see the fireworks But they could hear that all was going well with Agena In only ninety more minutes, they were to follow completing the first double launching in Cape Kennedy history Once in orbit, they were to attempt the first rendezvous and docking maneuver using the Agena as target

Six minutes later, the hand of fate moved across the sky to wipe out their flight plan and write a new script As the Agena separated from Atlas and began the sequence to fire its own main engine for the final push to a 185 mile circular orbit, it happened Midway through the sequence all signals ceased The Agena had exploded

Incredulous officials hoping it wasn't true waited until the target was due over Australia before scrubbing Gemini's flight. But when the target failed to appear on radar scopes they had no choice. Agonizing days of study and appraisal lay ahead.

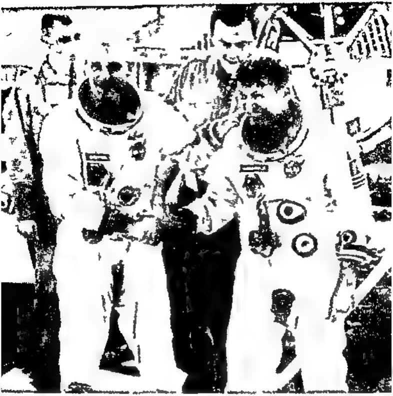
President Johnson, recuperating from a gall bladder operation at his Texas ranch, announced the next Gemini mission personally. Gemini VI would rendezvous with Gemini VII during the month of December. Two spacecraft, four astronauts would be in orbit at once. But how could it be done? There was only one suitable launch pad and repairs and checkouts took weeks each time after it was used.

This case didn't fit the rule books. The Titan rocket to be used by Schirra and Stafford was ready to go, having successfully passed every test. So was their spacecraft. Both were tenderly removed from the launch pad and placed in "bonded storage" at the Cape, ready and waiting. Under the plan, Gemini VII would be launched first on December 4. Before astronauts Frank Borman and James Lovell completed even one revolution, the Gemini VI rocket would be on its way to the pad. After nine days of intensive work, Schirra and Stafford were to join their friends in orbit. The plan was solid. It could be done.

It began at midday on December 4, the crisp air and blue Florida sky an omen of good luck for astronauts Borman and Lovell. The pair were ideally suited for the mental and physical strain involved in their record-setting endurance attempt of two full weeks in space.

Frank Borman is casual and easy-going often driving to work in a pickup truck He also is deeply religious a man who serves the Episcopal Church as a lay reader and actively seeks converts to his religion One such convert was Jim Lovell, who joined the church during their long training period as the backup crew for Gemini IV Though Lovell sometimes lets off steam behind the wheel of a sleek racing boat, his quiet nature and even temperament made him the ideal partner for the confining rigors of fourteen days in space Throughout the mission, he had an added thought never far from his mind — at home in Houston his high school sweetheart Marilyn Lovell followed the progress of Gemini VII while awaiting the birth of their fourth child, who was due any moment

Launch time for Gemini VII was chosen so that Borman and Lovell would be in phase — at exactly the right point in space — nine days later when Gemini VI left the pad The countdown was flawless Exactly on time, just three seconds past 2 30 P M man s longest space journey began Wearing their new lightweight suits, designed to be taken off in orbit, Frank and Jim went to work On the second day of the flight, flight director Chris Kraft, with the approval of Dr Chuck Berry, gave Lovell a 'go to doff his suit After packing the suit beneath his seat Lovell rode through space wearing thermal underwear For safety reasons, Borman remained in his suit — ready to button up if an emergency arose But a few days later, to Borman s delight, the astronauts switched roles and Frank was able to relax in the



Tom Stafford (*left*) and Wally Schirra shake hands on board the *Wasp* after their flight

waited calmly For this day at least, there would be no rendezvous

Anxious specialists rapidly began checking the Titan even as the astronauts were on their way back to crew quarters nearby The problems were soon discovered First the tail plug in the rocket had indeed fallen out The plug was to be pulled at lift off, starting the on-board clock When it fell away two seconds early, the au-

tomatic system began shutting down the engines The other problem was a small dust cover, inadvertently left in the Titan which obstructed the fuel line It had been in the rocket in October and would have prevented liftoff on that day too

This time as had not been the case with Gemini II there was no damage Two days later on the morning of December 15 they were ready to try again At 8 37 A M after another perfect countdown Schirra and Stafford were finally on their way In a series of intricate maneuvers they worked their way toward rendezvous As Tom fed numbers into the on board computer Wally manned the controls Five hours and fifty minutes later, Stafford s voice brought elation to those waiting on the ground We re one hundred twenty feet and sitting Rendezvous was accomplished'

Schirra pulled to within a foot of Gemini VII The four happy astronauts waved The eleven day growth of beard on Borman and Lovell brought chuckles from Wally and Tom Then Wally a Navy man all the way slapped a sign in his window to josh West Point graduate Borman Beat Army' it said Before they parted hours later Schirra and Borman made a bet about who would land closest to the carrier Then he pulled away to prepare for reentry the next morning

Wally and Tom had one trick up their sleeves before ending their historic flight Crossing the United States only hours before retrofire Schirra called down in a serious voice

This is Gemini VI We have an object looks like a satellite, going from north to south, up in a polar orbit He's in a very low trajectory looks like he may be going to reenter pretty soon Stand by! It looks like he s trying to signal us!"

On the ground waves of excitement clutched newsmen and controllers What did Schirra see? Was a flying saucer approaching the astronauts? Then it came loud and clear, just nine days before Christmas a tinny harmonica and a set of bells carefully smuggled into orbit, playing "Jingle Bells"! The UFO courtesy of Wally and Tom was none other than Santa Claus! A few hours later the flight was ended For his try at winning the bet with Borman, Schirra brought the spacecraft down just 6 4 miles uprange and one half mile to the left of the aiming point It would be a hard act for Borman to follow

But follow it he did On Saturday morning, December 18, Frank and Jim landed in the Atlantic only seven miles from the target The bet was a tie As they landed Borman and Lovell undisputedly held the world s record for space flight They had been aloft fourteen days completing 206 revolutions in 330 hours and 35 minutes And they were going home for Christmas

With the splashdown of Gemini VII the year 1965 in space came to a close Within the span of that single year the United States had completed six Gemini flights — five of them manned Rendezvous was an accomplished fact, Ed White had taken a space walk space endurance was stretched to four days then eight, then fourteen, ten

The Gemini VIII team that accomplished
the first successful rendezvous and docking maneuver
David Scott (*left*) and Neil Armstrong

and a half earlier Following the trail blazed by Schirra and Stafford the astronauts flawlessly tracked the Agena until six hours after lift off they sat quietly only 150 feet away from the glistening rocket

Then came the moment that Schirra and Stafford had missed Throttling the spacecraft forward Armstrong smoothly slid the nose of their spacecraft into the Agena s docking collar At first contact the collar con

tracted pulling Gemini up tight and locking it in place Two vehicles launched separately had become a single spaceship

"It was a real smoothie, Armstrong reported But twenty-seven minutes later, the world seemed to fall apart! Paul Haney s tense straining voice galvanized reporters into action

"We ve encountered some trouble in the flight, Haney said Neil Armstrong has backed off from the Agena He s using one of his RCS rings to maintain attitude We are watching the situation very carefully

For agonizing minutes that stretched into an hour additional reports clarified the situation A short circuited Gemini thruster had sent the spacecraft Agena combination into a violent spin To regain control the astronauts undocked and began using their rate command system (RCS) thrusters which are normally used only during reentry It meant they would have to come down immediately!

As recovery aircraft took to the skies from their Okinawa base the destroyer *Mason* steamed toward the point in the Pacific where Armstrong and Scott would make their emergency landing While Gemini control held its breath they began their descent out of range of any tracking stations They plunged through the atmosphere with a calm precision unmatched by any previous crew As their main parachute opened excited voices from the recovery planes reported to Houston that Armstrong and Scott were in sight just three miles away Swim

teams joined them within seconds after landing, almost on target seven hundred miles from Okinawa The astronauts were safe after the first manned space flight ended by an emergency But they had accomplished their primary goals they had rendezvoused with an Agena, they had completed a docking maneuver, they had made a perfect reentry Though the flight ended early, it added much to the knowledge that would take Americans to the moon

Four flights remained in the Gemini program The objectives of all included rendezvous dock space walks Each in its own way was different yet each was somewhat the same Gemini IX was beset with both trouble and tragedy Just two weeks before the Gemini VIII flight, astronauts Elliot See and Charles Bassett who *were to fly aboard Gemini IX, died in a tragic plane* crash at the St Louis airport In their place went now-veteran Tom Stafford and his new partner Gene Cernan It was the fourth time Stafford had been ready for a lift-off, and the third time that something happened to prevent his flight Shortly after their Agena target was powered upwards by the usually reliable Atlas a malfunction in the booster sent it arcing over into the Atlan tic 'Do you do this for living?" asked the incredulous Cernan as they unbuckled seat belts and left their ship

But it wasn t over yet To replace the Agena in case just such an accident occurred, McDonnell Aircraft Cor poration had built a stocky, engineless target called the augmented target docking adapter It was soon to become better known as the "angry alligator On June 1

1966 everything was ready for another try This time the substitute target blasted into a perfect orbit 185 miles high For the fifth time Tom Stafford was buckled in and ready to go Next to him Gene Cernan kept his fingers crossed

And it happened again! With less than three minutes to go in the countdown a ground switching center in the blockhouse failed to send updated information to the Gemini computer The sequence was tried again and it failed again This time carrying the nickname from Li'l Abner of Joe Btfsplk Tom Stafford led Cernan back to the crew quarters His lift off average was exactly 0 2 — one out of five times he had made it

Two days later they tried again But in the meantime ground signals indicated that the clamshell shroud on the orbiting target had not fallen away On June 3 Tom and Gene were on their way to find out why Midway through the third revolution they caught their target over Hawaii and reported to earth

We ve got a weird looking machine here Stafford called Both the clamshells of the nose cone are still on but they are wide open The jaws are like an alligator

Once again there would be no docking in space for astronaut Thomas P Stafford But that didn t stop either Stafford or Cernan from completing the rest of their mission Before the first day was over they had blasted away from the angry alligator then found it again for a second rendezvous Overnight they separated from it while they slept then skillfully performed a third ren-

Astronauts Eugene Cernan (*foreground*) and Edwin Aldrin Jr on a water training exercise

dezvous the following morning A day later, they opened the hatch and Gene got out — the first American since Ed White to take a walk in space But even that didn t go quite as planned His space walk was scheduled for a record two and a half hours during which he would don a back-pack maneuvering unit carried in the rear of the ship then flit about under its power Instead when the spacecraft went from sunlight to darkness Cernan found

himself fogged in Vapor covered his faceplate, dropping his visibility to nearly zero

"It s no go for the AMU," Stafford called, and the nearly blind Cernan made his way back to the spacecraft The astronaut maneuvering unit would have to get its next workout on Gemini XII The end of the flight came on the morning of the fourth day and marked the most accurate landing to date Clearly in sight of the aircraft carrier *Wasp*, and with a nationwide audience watching on television, Stafford brought Gemini IX down a half-mile from the aiming point He was right on target and he knew it 'Are we on television? Are we on television? he asked as they descended under their billowing parachute And with pinpoint accuracy they were

Now Gemini entered its closing phase John Young and Mike Collins turned their Agena into an orbiting tanker during Gemini X by using its big 16 000 pound-thrust engine to literally power their way around the sky In the process they set a new world s altitude record of 476 miles and made good an additional and tricky rendezvous with the Agena still in orbit from Gemini VIII Then as John Young pulled in close Mike Collins took a space walk to retrieve a micrometeorite collector that it had carried for more than four months At two other points in the mission Mike opened his hatch once to stand up for some high altitude photography and a final time to dump into space the bulky hoses and equipment he used on the space walk The triple hatch opening was another first for Project Gemini

The fourth Gemini flight of 1966—Gemini XI—

Astronauts Michael Collins (*left*) and John Young

was designed to send the veteran of two weeks of space flight Charles Pete Conrad the U S s only Princetonian astronaut and rookie astronaut Dick Gordon to significant new records of both altitude and extravehicular activity (EVA) experience

After lift off on September 12 Conrad deftly maneuvered his spacecraft to a first time rendezvous on the initial orbit He caught up with his Agena target in

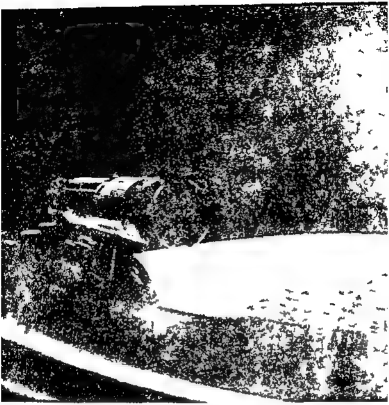
fact about three fourths of the way through his first orbit This highly precise maneuver was a direct preparation for Project Apollo for virtually the same fuel-conserving maneuver would be required of the two astronauts who would blast up from the lunar surface for a life or death rendezvous with the lunar orbiting command and service module that would ferry them back to earth

Dick Gordon encountered unexpected difficulty during his walk in space and spacecraft commander Conrad ordered him back in on the first day But other than this difficulty the mission so far was proceeding well

On the second day Conrad began a new maneuver that was eagerly awaited by U S aerospace engineers After again docking with Agena and as Gemini XI passed over the Canary Islands Conrad properly aligned his joined spacecraft, then triggered a twenty five second blast of the big Agena rocket This precisely timed burn thrust them on a new orbital course that gradually carried them higher By the time they reached Australia fifty-one minutes later they had peaked at an altitude of 850 miles — 374 miles higher than Young and Collins had been in Gemini X and 542 miles higher than the Russian record set by their Vostok II

We re on top of the world Conrad exclaimed It s utterly fantastic

When their color pictures were later processed and released the world saw the most remarkable earth pictures ever taken One view covering nearly a fifth of the



The Agena docking vehicle seen from Gemini X during rendezvous maneuvers

Northern Hemisphere showed the entire Red Sea and the Gulf of Aden in a single sharp exposure

By the time they looped around to their orbital low point on the far side of the earth they were traveling 17 897 miles per hour, faster than any man had ever before gone By the time Gemini XI splashed down within two and one half miles of the recovery ship Gordon had

stood up in his seat for over two hours taking star photographs even though his earlier 115 minute space walk had had to be shortened to just forty four minutes The crew had also successfully tethered Gemini XI to Agena with a one hundred foot nylon line, thus proving feasible a fuelless method of "station keeping"

The final mission in the series, Gemini XII, was known as the 'catchall flight' In it, veteran Jim Lovell and America's first Ph D astronaut Edwin Buzz Aldrin were to fulfill an extensive list of assignments — from docking to EVA to motion and still photography of a solar eclipse The selection of thirty eight year-old Navy Captain Jim Lovell as Gemini XII commander was, to me a particularly satisfactory choice I knew the flight would make him the most experienced space pilot in the world I had gotten to know Jim Lovell who was among the second group of U S astronauts and his wife Marilyn perhaps better than any other astronaut family and I was very fond of him For over a year I kept my one hundred horsepower outboard boat, which I had bought from Gordon Cooper tied up at Jim's dock on a shady canal branching off from Taylor Lake and I recall one incident from that time which shows the kind of person Jim Lovell was One cold night my son and I were launching our boat down a ramp but due to extremely low water both the trailer and boat became mired in the Texas mud When Jim noticed that both of us happened to be wearing rolled up flannel trousers he immediately walked out in the cold water with his shoes and socks still on grabbed

the transom of the boat and manhandled it out into deep water The fact that he got his own trousers mud soaked seemed incidental to him "Aw, it ll just wash right out he said ' No problem

Jim and Marilyn had attended the same high school in Milwaukee—Soloman Levi High School—and just before his first flight I had addressed my well-wishing telegram from Houston to 'the pride of Solo man Levi" Somehow it got delivered to his ready room quarters in Cape Kennedy s hangar S But I happened to be away on a trip just before the lift-off of Gemini XII and during the flight, it worried me that I had neglected to send Jim a wire wishing him success Nevertheless from the beginning Gemini XII was doing a fine job of bringing down the curtain on the series Lift off of their 430,000 pound thrust Titan booster occurred just 0 45 seconds after the preset schedule

Lovell linked up with the twenty six foot Agena four hours after launch and after their night s sleep of ten hours Buzz Aldrin successfully performed the first of three open hatch experiments as well as a number of the fourteen scientific experiments on their schedule The technical gremlins and glitches that had sometimes marred previous flights seemed to be taking a holiday Before Aldrin splashed down in a heavy sea he had re mained outside without apparent difficulty for a new record five hours and thirty seven minutes The flight which came to an end on November 15 gave Jim Lovell a total of nearly eighteen days in orbit, in which he had

sign that had greeted Lovell and Aldrin when they walked to the elevator which would hoist them to the top of their rocket The sign read NOTICE LAST CHANCE NO RERUNS SHOW WILL CLOSE AFTER THIS PERFORMANCE

The next phase in U S manned space flight belonged to Project Apollo our national program to land astronauts on the moon, and the first chapter of that phase was to begin with a triple tragedy Just ten weeks after Lovell and Aldrin returned to earth from the curtain flight of the Gemini program, the new, three man Apollo spacecraft was being groomed for its first manned flight at Cape Kennedy s pad 34

On Friday, January 27, 1967 the white top-shaped Apollo rested two hundred feet above the ground atop the new Saturn rocket Locked inside, undergoing a pre-flight check-out, were veteran astronaut Gus Grissom scheduled to become the first spaceman to pilot all three U S spacecraft, space walker Ed White and a popular new astronaut, Roger B Chaffee thirty-one who was born in Michigan and who was graduated from Purdue University before entering the United States Navy as a pilot No one at Cape Kennedy that afternoon was aware of the presence of danger The chief source of danger the Saturn rocket itself was not even fueled The three space suited astronauts sat calmly inside To be sure, the atmosphere inside was 100 per cent pressurized oxygen but everyone was aware that astronauts had survived days in both Mercury and Gemini in a similar environment Grissom White and Chaffee seemed as safe on earth as

the technicians watching them from a thousand feet away on closed circuit television

Then at 6 31 P M., through the static of a poor radio link a technician in the blockhouse heard the shouted word Fire! He thought the voice was that of Gus Grissom A few seconds later there were assorted cries of pain Death was almost instantaneous as a spark from a faulty electrical connection sent an instant surge of white flame through the spacecraft somewhat like the swoosh of a lighted gas oven In the pure oxygen atmosphere nylon velcro and other materials in the spacecraft s interior ignited like iron filings blazing up in a laboratory oxygen flask The now raging fire fed by an antifreezelike liquid called ethylene glycol quickly heated up the spacecraft scorching its outer shell Rescuers who tried to reach the sizzling spacecraft were forced back by waves of heat and acrid smoke two had to be hospitalized It took five minutes to get the hatch open and it was seven and a half hours before the charred remains of three valiant men were taken to an infirmary for autopsy

The exact cause of the fire will probably never be known After millions of accident free orbital miles, after half a dozen near accidents or close calls in space an unanticipated and unprepared for ground accident had vanquished three hard working astronauts and in the process stopped Project Apollo in its tracks

Three months later the Russians also lost a space pilot cosmonaut Colonel Vladimir Komarov The first Apollo flight originally scheduled for February 21 1967

had not yet been rescheduled and it was certain not to take place until 1968

When the inquiries were concluded and all the necessary corrections and modifications were made to the newest U S spacecraft, the tragedy on pad 34 would ultimately cause at least a full year's delay in the attempt to land an American on the surface of the moon

19

The Moon and Beyond

AT 2:55 A.M. back on the foggy morning of November 8, 1958, the glow from a rising eighty-eight-foot rocket had turned Cape Canaveral's ground fog to an unbelievably gold color. Two hours later I saw the moon, some 245,000 miles away, rise majestically above the fog. Its gleaming orb was now a bull's-eye for a lunar probe known as Pioneer I that, even then, was speeding away toward the moon. Pioneer I did not complete its date with history. When it was one third of the way to the moon, it slowed, arched slowly over and then was sucked back by the commanding gravity of earth. Ever since, the alien, hostile, romantic, formidable, mysterious magnet of the moon has imposed a demanding mission on the creatures of earth. Man will not rest until he has physically reached his first solid destination, his celestial island of desire that burns its cold and beckoning light in the black dome of the sky.

Projects Mercury, Gemini, Ranger, Surveyor and Lunar Orbiter all brought that date with destiny within reach during the first accelerated decade of the space

age And it was within reach of either of the two most powerful and competitive nations on earth As 1967 dawned the fiftieth anniversary year of the Russian revolution and the tenth year since U S ballistic payloads had broken through the outer limits of the earth's atmosphere, no one could predict with certainty which nationality the man would be who first stepped out on the ancient and virginal surface of our nearest neighbor in space The fact that the question, from a scientific standpoint was academic could not dissuade the partisans of both countries from the drive and sense of impending adventure that has always characterized any pioneer exploration

By 1967, both countries had the booster power required not only to send men to the moon but also to perform years of related exploration In fact, the question of competitive booster power, which long had suffered from a series of speculative overexposures in the popular press was now entirely incidental Deciding on which booster to use was somewhat like deciding on the number and type of elevators to install in for instance, a new Hilton hotel If you wanted to lift a lot of weight at once, you would have the capability of one cavernous elevator that would do the job But if you wanted to use several smaller elevators to lift an equal amount of weight, this was also possible and perhaps, more desirable So it was with boosters Both the United States and Russia now had more than adequate lifting power to provide them with a decade of highly serviceable space missions — both scientific and military The U S 's Saturn 5

thirty six stories high, was so huge that neither the U S Air Force nor NASA could delineate any specific use for it beyond Project Apollo — our nation s program to send men to the moon within this decade

There was no question that the coming decade would see not only the initial conquest of the moon but also the orbiting of large permanent multipurposed and multimanned orbital space stations, regular ferry service to semipermanent lunar outposts, deep space missions that would send men and instruments far beyond the confines of the earth moon axis perfection of routine satellite service in the areas of communications, meteorology and astronomy and a fearful and unknown application of military vehicles and personnel in the new space realm

"Whether we like it or not, John Glenn once pointed out "space has now become the province of fallible man And wherever man has learned to live, he has also learned to fight

The second decade of the space age would also see a massive although basically unpredictable, fallout of space-wrought technology to industry and to the lives of all the people of the earth

During the first decade such by-products from the space effort were slow in coming and often disparaged by that influential element of the scientific fraternity — notably atomic physicists — who were congenitally and persistently soft on space Nevertheless in retrospect such side benefits were considerable, especially after the mid 1960s In 1966, *Time* magazine summarized 'From drugs to golf carts house paint to brassieres the space

age is beginning to produce some down-to earth by-products Enough space-inspired products have already reached the marketplace to prove that every tax dollar invested in space will multiply many times in the economy"

Among space age fallouts to industry were plastic railway tank cars, new corrosion resistant alloys especially of titanium, found useful in oil refineries, new means of coloring aluminum without welding, large and revolutionary new transport aircraft such as the Super Guppy' whose 22½ ton capacity can be used for both rockets and large computers oil rigs and helicopters new types of construction sealants for automobiles, heat-resistant smoking-pipe liners, fuel cell power for submarines, tractors and even golf carts, laminating techniques in brassiere construction, and a host of quality control devices for industrial production

By the late sixties, space was becoming the peacetime equivalent of a major war in that it served as the great synthesizer of science Virtually every scientific field — from astrophysics to zoolitics — was embraced by the expanding world of astronautics on both sides of the iron curtain The deputy director of NASA s Manned Spacecraft Center in Houston put it this way Every age of technological development has had its catalyst and it usually was war The space program is today's catalyst Any prediction of what will happen in the next five years will be ultraconservative'

Just being present for the next five years and the next unpredictable decade will be an unparalleled adventure

for man as he explores deeper into the possibility that he may have an important destiny away from his home planet. For there is something strangely magnetic and contagious about probing into the secrets of the universe and exploring the broadening sea that twentieth century man finds himself in. It spurs his energy and dominates his subconscious. Are we merely extending our horizons? Or are we consumed by a deeper passion, a powerful yet subtle motivation to find out — now that we have the means — whether some other form of life has done a better job with its resources than we with our great legacy of forests, water, productive soil and a benign atmosphere? Is this the root of our drive and the measure of our response to the lure of the cosmos. Or are we like ancient nomandic tribes who watched their water holes go dry, unconsciously seeking new pastures far from our overcrowded home? Or are we driven toward distant shores by our knowledge that we are making the earth sullied and polluted at the same moment when we have gained the capacity to destroy it utterly — willfully or accidentally?

Such questions, touching some of the most profound of human existence, were not entirely unknown when Columbus, Magellan and the Vikings set sail across the chartless seas of the earth. The answers may never wholly be found, but those who witness or participate in the next decade of space, and the next after that, will assuredly find some of them. For life is now venturing beyond the land as it once ventured beyond the sea. As we once learned to substitute the nourishment of air for the

nourishing and rich broth of the sea, so we are now learning to live where there is no air and no comforting and warming atmosphere. Not until life moved out to dry land could it see the stars; and life will not be content until it has reached them.

APPENDIX 1

The Language of Rocketry

DURING THE PAST half-century, a revolutionary new means of transportation the airplane helped to fill English dictionaries with hundreds of new words from aileron to airfoil and from runway to shock strut In addition scores of slang words and expressions such as prop wash, hot pilot, stick jockey, grease job and many others, found their way into everyday language With the sudden emergence of missiles and rockets the working language is again being transformed just as the leather jacket of the early aviator has given way to the hard hat of the missileman The sudden influx of new terms has already become such a problem in the space age that both individual contractors and government agencies have been compelled to issue long lists of definitions which must be constantly revised and enlarged

Many of the words rocketmen use have been a part of the language for years and are only now being called upon in everyday conversation Others are brand-new terms Rocketmen like aviators, invent humorous terms and expressions whenever they can Once I heard an

RCA technician obviously taking off on the number of Germans in our missile programs refer to the Thor-Able rocket as follows (Thor Able is a combination of Thor main stage and a Vanguard second stage) : *Der mizzelmix mit das Thor schutzen und mit Vanguard von der schnozzel ist* ! Incidentally when two stages are thus joined they are in rocket terms "mated or 'married"

Sometimes fun loving rocketmen will deliberately exaggerate the use of their specialized language I once asked a range safety officer to explain how a faulty missile can be stopped in early flight He replied with obvious satisfaction After a green bird has cooked on the pad and reaches first motion if it fails to program in an X direction or wanders outside the family of destruct criteria fail safe imposes a condition of zero lift Translated, this meant simply that if the rocket wanders off course it can be automatically destroyed

Another rocketman once told me, "What this program needs is more input of hard stars [money] and less eyeball instrumentation [inspection] from the Washington orbit heads [rubbernecking Congressmen]

Not only are the words new but also in many cases, the jobs themselves Fifteen years ago the following job descriptions did not exist drum patter pad safety officer telemetry engineer interference control officer trajectory mathematician sky screen operator flame attenuation observer and many others

Whenever possible rocketmen will take a technical term and convert it into everyday language But by and large rocketmen live and work with a vast catalogue of

specific engineering terms The following is a list of some of the more interesting or more frequently used terms of the new rocket language Not all are new words by any means, but most are now being widely employed by rocketmen

Glossary

ABLATION Boiling effect on the surface of the heat shield to dissipate the intense heat of atmospheric friction during reentry

AGENA Maneuverable unmanned satellite used for Gemini rendezvous docking experiments

AMU Astronaut maneuvering unit originally planned for *but not used in Gemini series*

A O K Slang term All O K , everything is working properly

APOGEE Highest point of an orbit

APS Accessory power supply for a complete missile

ASCS Control system for maintaining attitude of a spacecraft

ASTRO Short form for astronautics or astronaut

ATDA Augmented target docking adapter better known as the angry alligator

ATLAS Air Force intercontinental ballistic missile Designated SM 65 Atlas was the first U.S operational ICBM

ATTITUDE Aerospace term referring to the orientation of a spacecraft in relation to the earth s horizon

AU Astronomical units A unit of length equal to the mean radius of the earth s orbit, or about 93 million miles

AURORA 7 Second U.S orbital spacecraft, piloted by Scott Carpenter

BALLISTIC In rocketry refers to the laws governing a mis-

CATCH NETS Rigid nets attached to disconnect towers to prevent damage to umbilical cords when they drop away from a missile

CHAFF Small strips of metallic tinsel released by a reentering spacecraft to facilitate radar tracking

CHERRY PICKER Elbowed crane whose cab is placed beside the spacecraft on the launch pad to enable the astronaut to escape in an emergency

CHICKEN SWITCH Slang term for the control level beside the astronaut's left knee which can separate the capsule from the booster rocket in an emergency

COMPUTER LANGUAGE Machine language combination of letters and numbers

COMSAT Communications satellite or abbreviation for Communications Satellite Corporation

CONSOLE Desk type stand which controls a specific phase or process of a missile A blockhouse is filled with consoles

CONTOUR COUCH Personally tailored formfitting seat into which an astronaut is strapped

CONTRAIL Short term for condensation tail, a visible trail of water droplets or ice crystals formed at certain altitudes in the wake of a missile or aircraft

COSMIC RAYS Extremely fast particles continually entering the upper atmosphere from space

COUNTDOWN The step by step process leading to a missile launching performed in accordance with a predesignated time schedule

COURIER Early military communications satellite

DATA DEDUCTION Conversion of coded information collected by a missile into usable information

DESTRUCT BUTTON Switch on the console of the range safety officer which when pressed destroys a missile in flight

DESTRUCT PACKAGE An explosive or other device for destroying a missile or one of its components intentionally

Most destruct packages can be detonated by radio signals

DISCONNECT TOWER Umbilical tower which stands very close to a missile at launch Power and fuel lines run from the disconnect tower to the missile

DISCOVERER Air Force project now classified designed to recover a returning reconnaissance satellite by means of aircraft

DOPPLER EFFECT Apparent change in frequency of a sound or radio wave reaching an observer or a radio receiver caused by a change in distance or range between the source and the observer (or receiver) during the interval of reception

DOVAP Abbreviation for Doppler velocity and position Used in missile tracking (*See* Doppler effect)

DOWNRANGE Any point in the 5000-mile long Atlantic Test Range extending from Cape Kennedy to the south Atlantic

DRIFTING FLIGHT Continuation of a spacecraft in orbit without the use of any control system to adjust or maintain a particular attitude or orientation toward the earth

DROGUE Small parachute (six feet in diameter) which slows and stabilizes a reentering spacecraft beginning at about 21 000 feet

DRONE Pilotless aircraft usually a B 17 flown by radio control without a pilot aboard Drones are used as targets for interceptor missiles but are intentionally seldom actually hit

EARLY BIRD Trademark Communications satellite which appears fixed above the earth s surface (in a synchronous orbit) and which relays transoceanic microwave signals

ECHO Large balloon satellite whose size and silver colored skin lend it high visibility used for bouncing radio signals back to earth

EGADS Electronic ground automatic destruct sequencer, used to keep a missile under control of the nearest de struct transmitter

EGRESS In rocketry the method and process of an astronaut s leaving the spacecraft

EKG Abbreviation for electrocardiogram a device for measuring heart reaction

ELDO European Launcher Development Organization a group of countries engaged in a joint satellite development program

ESCAPE ROCKETS Three rockets above the spacecraft which when fired pull the spacecraft free of the booster (for use in an emergency)

ESRO European Space Research Organization a group of countries engaged in joint space research

EVA Extravehicular activity, outside a space vehicle

EXPLORER The first U S artificial earth satellite launched January 31 1958 also a series of satellites designed to study the upper atmosphere

FAIRING Cover designed to reduce drag due to air friction

FAITH 7 Sixth U S manned spacecraft piloted by Gordon Cooper for a record twenty-two orbits

FIRST MOTION First movement of a rising rocket, compares to takeoff or 'lift off

FLAME BUCKET Large exhaust deflector in a launch pedestal which diverts rocket exhaust to a horizonal direction

FLY BY WIRE Semi automatic control system somewhat similar to power steering on an automobile with which an astronaut flies a spacecraft a flight mode

FREEDOM 7 The name selected by Alan Shepard of the first Project Mercury spacecraft launched in America Freedom 7 is now in the Smithsonian Institution

FRIENDSHIP 7 First U S orbital spacecraft piloted by John Glenn

G FORCES Gravity pressures acting on an astronaut during lift off and reentry A force of one G means his body weight is doubled

GANTRY Tall service structure or crane which prepares a rocket for flight

GIMBAL Mechanical frame which enables a rocket engine to swivel in any direction required to maintain a course

GLENN EFFECT Official name of the still unexplained phenomenon of the fireflies John Glenn reported seeing in space

GO Missilemen refer to a status or condition as go or 'no-go 'Go means the same as A O K or green

GREEN Rocketry term stemming from the use of green signal lights to signify that a function is working or that an event has properly taken place

GREENHOUSE Clinically clean glass walled room which surrounds the spacecraft while it sits on the pad The greenhouse is attached to the gantry

HANGAR S Missile hangar in the Cape Kennedy industrial area where Project Mercury rockets were checked and where the astronauts lived just preceding flight

HEAT SHIELD Strong insulating disc six feet in diameter which protects the inside of a spacecraft from severe atmospheric heat during reentry

HOLD Unscheduled and usually temporary delay in the countdown leading to a missile launching

HORSE COLLAR Sling lowered by a helicopter to recover an astronaut from the water

HYDROGEN PEROXIDE Fuel which when turned to steam activates small jets which control a spacecraft s attitude in space

HYPERGOLIC Ability of propellants to ignite spontaneously upon mixing

ICBM Abbreviation for intercontinental ballistic missile range is normally over 5000 miles

IGNITER Device which starts the fire in the combustion chamber compares to a sparkplug

IMP Interplanetary monitoring probe

IMPACT Point and time at which a spacecraft lands

IMPACT CONE Circle on the earth s surface into which a missile will fall In flight the impact cone is constantly moving

INSERTION Point at which a spacecraft enters an orbit

IONIZATION LAYER Superheated air which surrounds a space craft on reentry temporarily blocking all radio and radar signals

IRBM Abbreviation for intermediate range ballistic missile range is normally about 1500 miles

JATO Abbreviation for jet-assisted takeoff — the takeoff of a cruise missile or aircraft using an auxiliary booster (or the booster bottle itself)

JET VANE Heat resisting material (usually graphite) placed in the exhaust stream to change a missile s course

JETTISON To discard or deliberately lose an object such as the retro package, in flight

JPL Abbreviation for Jet Propulsion Laboratory A lab oratory of the Guggenheim Aeronautical Laboratory at the California Institute of Technology

JUNO First U S payload to escape the earth s gravity and orbit the sun

JUPITER Intermediate range ballistic missile Designated SM 78 developed by the Army at Redstone Arsenal

LAUNCH The initial motion in the flight of a missile

LAUNCH PAD Location or complex from which a rocket is launched

LIBERTY BELL 7 Second U S suborbital spacecraft piloted by Virgil Grissom

LOX Short term for liquid oxygen a supercooled liquid used as an oxidizer in liquid fuel rockets

LUNAR ORBITER Satellite series which photographed the lunar surface while orbiting the moon

MA 6 Abbreviation for John Glenn s rocket Mercury-Atlas 6

MA 7 Abbreviation for Scott Carpenter s rocket Mercury-Atlas 7

MALFUNCTION Failure of a piece of missile equipment or failure of a component to function normally

MANUAL CONTROL Mode of flight of a spacecraft in which an astronaut actually flies by hand without the use of the automatic control system

MATADOR Air Force tactical range missile Designated TM 71 the Matador was the Air Force s first operational sur face to surface missile

MERCURY ATLAS Three engine rocket ninety three feet tall that boosted John Glenn Scott Carpenter Wally Schirra and Gordon Cooper into orbital flight

MERCURY CONTROL Electronic and command headquarters for all Project Mercury flights Mercury Control was in a concrete building about a mile from the launch pads

MERCURY REDSTONE Intermediate range rocket developed by the U S Army which propelled Alan Shepard and Virgil Grissom into space

METSAT Meteorological satellite

MICROMETEORITE Tiny dust particle in space

MIDAS U S Air Force reconnaissance satellite launched from Vandenberg Air Force Base usually on a polar orbit

MINIATURIZATION Process of making rocket components especially electronic equipment, as small as possible to conserve weight

MODE In rocketry the method (one of three) by which a spacecraft is kept in proper attitude or orientation

MR 3 Abbreviation for Alan Shepard s rocket Mercury-Redstone 3

MR 4 Abbreviation for Virgil Grissom s rocket Mercury-Redstone 4

NAVAHO Early supersonic cruise missile of intercontinental range developed by the Air Force now discontinued

NAVSAT Navigational satellite

NOLO FLIGHT Flight of a drone aircraft without a pilot aboard

OAO Orbiting astronomical observatory

OGO Orbiting geophysical observatory

ON BOARD On or within a space vehicle

OPTICAL TRACKING Method of following a rocket through visual instruments such as a telescope or telescopic camera known as a theodolite

ORBITAL FLIGHT Space flight which circles the earth

OSO Orbiting solar observatory

OXIDIZER That portion of a rocket s propellant, usually liquid oxygen which causes the fuel to burn at maximum efficiency

PAD Short term for launching pad the surface on which a rocket launcher is placed

PARARESCUEMEN Parachutists who jump from rescue aircraft to assist recovery of an astronaut and his spacecraft from the ocean

PAYLOAD Whatever the missile carries — warheads mail instruments animals human beings

PERIGEE Lowest point of an orbit

PIONEER Series of early rocket flights aimed at the moon

POLARIS Two stage solid fuel Navy IRBM now under development designed primarily for launching from submarines

POSIGRADE ROCKETS Small rockets which propel the capsule away from the booster in flight

PRESSURE SUIT Thirty pound rubberized suit worn by an astronaut in flight sometimes called a space suit

PRIME ASTRONAUTS First three astronauts selected for space flight Alan Shepard Virgil Grissom and John Glenn

PROGRAM Planned flight events to be followed by a missil Also used as a verb to describe the turn of a ballisti missile from vertical motion after lift off to a curved pat approximating the desired powered flight trajectory before the initiation of guidance

PROJECT APOLLO U S program designed to land men on and return them from the moon within this decade using the third or three man family of spacecraft

PROJECT GEMINI Space exploration involving the second U S family of spacecraft the two-man Gemini (Gemini means twins)

PROJECT MERCURY Official name of the first U S manned space flight program

PROPELLANT Either the oxidizer or fuel or both used to propel a missile

QUICK LOOK DATA First information gained about a missile flight based on a hasty analysis of the most essential material recorded and decoded

REAL TIME DATA Data recorded as events take place not stored

RED Rocketry term signifying that a process is not working or that a planned event has not taken place a no-go condition.

REDSTONE Army tactical range ballistic missile The Red

stone is deployed in Europe and has a range of two hundred miles

REDUNDANCY In rocketry the method by which the primary means of doing something is backed up by two or more additional means in case the primary means fails

REENTRY PHASE Final part of a spacecraft s flight when it is exposed to heat friction and buffeting as it reenters the earth s atmosphere

REP Rendezvous evaluation pod used as a substitute for Agena in Gemini 5 to evaluate radar

RESPIROMETER Device attached to an astronaut s neck to measure his rate of breathing during flight

RETRO Short term for retro rocket a rocket that gives thrust in a direction opposite to the direction of lift off thrust

RETRO PACKAGE Cluster of three retro rockets plus holding straps located at the center of the heat shield

RETRO-ROCKETS Three small rockets located on the heat shield which slow or brake the spacecraft s flight, thus enabling it to be pulled back to earth by gravity

ROTI Abbreviation for recording optical tracking instrument a tracking telescope camera used at the Air Force Missile Test Center with a 24 inch telescope opening and a 500-inch focal length

RUBBER SACK Nickname for the rubberized nylon inner layer of an astronaut s pressure suit

SATURN Largest rocket so far tested in the free world now being prepared for a manned shot to the moon

SCRUB Missile slang to indicate cancellation of a scheduled flight

SERVO Short term for servomechanism in which control of position speed power output etc is effected by a device or devices that automatically change or correct position

speed power etc in accordance with a predetermined setting or manipulation

SHOOT A missile launching

SIDE ARM CONTROLLER Control stick used by an astronaut to change the attitude of his spacecraft

SIGMA 7 Fifth manned spacecraft piloted by Walter Schirra

SILO Type of underground launching tube

SKID STRIP Single runway inside Cape Kennedy formerly used by returning Snark missiles, now used by airplanes

SKY SCREEN Equipment used to determine the exact instant a missile deviates from its programmed flight

SLV Satellite launching vehicle

SNARK Air Force intercontinental range cruise missile Designated SM 62 the Snark was assigned to the Strategic Air Command

SOFAR BOMB Explosive bomb designed to be dropped and to detonate underwater to signal the location of a descending spacecraft

SPACE WALK Act of moving or floating outside a spacecraft

SPUTNIK Russian name for the first Soviet satellite

SQUAWK BOX Loudspeaker All over Cape Kennedy squawk boxes carry the voice of the man who talks the progression of a countdown

SQUIB Small device sometimes used to fire the igniter

SUBORBITAL FLIGHT Space flight which carries a spacecraft above our atmosphere on a path similar to that of a bullet but which does not orbit the earth

SUBSATELLITE A satellite launched from another satellite already in orbit

SURVEILLANCE Observation of the range corridor to determine that it is clear also observation of the missile itself

T Abbreviation used for time during a missile countdown (as in T minus 5 minutes) Launch time is T

TELEMETRY Method by which rocket flight information is radioed to earth

THEODOLITE Rocket tracking device combining a telescopic lens with a motion picture camera

THERMAL UNDERWEAR Specially designed porous underwear worn by astronauts under their pressure suits

THOR Air Force intermediate range ballistic missile Designated SM 75, the Thor first became operational at bases in the United Kingdom

THRUSTER Spacecraft attitude control jets

TIROS Television infrared observation satellite Meteorological satellite which relayed cloud cover to earth

TITAN Air Force two-stage intercontinental ballistic missile Designated SM 68 the Titan was assigned to the Strategic Air Command and to NASA s manned spaceflight program

TRANSIT Satellite used by ships at sea especially U S nuclear submarines to plot their position and obtain a navigation fix

TRANSPONDER Electronic device which can receive a challenging signal and automatically transmit a response

TV 3 BACKUP Vanguard which followed test vehicle number 3 in the Vanguard program

UDMH Abbreviation for unsymmetrical diamethyl hydrazine one of the so called 'exotic' missile fuels

UMBILICAL BOOM Tower adjacent to a rocket which supports electrical and fuel lines which feed into the rocket while it is on the ground

UMBILICALS Cables fitted to the missile with quick disconnect plugs through which missile components are controlled and tested before a launching Umbilicals fall clear just before lift off

VANGUARD The project (and rocket) originally designated

to orbit the first U S artificial satellite but Explorer got there first

VERNIER Small rocket engine or gas nozzle mounted on the outside of a missile to control roll pitch and yaw it can be adjusted by command from the ground during powered portion of a flight

VOSTOK Russian word meaning east the name of the first spacecraft to achieve orbital flight Vostok piloted by Yuri Gagarin orbited the earth three times April 11 1961

VOSTOK II Russia s second manned spacecraft which on August 6 1961 carried Herman Titov on seventeen orbits of the earth

WEIGHTLESSNESS State of floating free of gravity — characteristic of all space flights so far made

ZERO G Complete weightlessness in space

APPENDIX 2

American Space Flights, 1957-1967*

Name	International designation	Launch date	Payload weight (pounds)	Period (minutes)	Perigee (statute miles)	Apogee (statute miles)	Inclination from equator (degrees)	Status
Vanguard TV 3	None	12 6 57	3					Failed to orbit lost thrust after 2 seconds
Explorer 1	1958 A 1	1 31 58	31	114 7	24	1584	33 3	In orbit transmitted until 5 23 58 discovered Van Allen radiation belt
Vanguard TV 3 backup	None	2 5 58	3					Failed to orbit control systems malfunction
Explorer 2	None	3 5 58	[illegible]					Failed to orbit unsuccessful fourth stage ignition
Vanguard 1	1958 B 2	3 17 [illegible]	3	134 3	405	2462	34 3	In orbit transmitted pear shaped earth data until 5 64
Explorer 3	1958 Γ 1	3 26 58	31	114 7	117	1739	33 5	Decayed 6 28 58 radiation micrometeoroid data until 6 16 58

* Reprinted from *TRW Space Log* published by TRW Systems Group TRW Incorporated Redondo Beach California Source advises that *since some assumptions were made* in correlating this information it cannot assure complete accuracy in the resulting data Date of compilation *March 196*

Discoverer 3	None	6 3 59	1600					Failed to orbit; Agena fired, no satellite signals received
Vanguard SLV 6	None	6 22 59	23					Failed to orbit; second stage propulsion malfunction
Discoverer 4	None	6 25 59	1600					Failed to orbit; insufficient second stage velocity
Explorer S-1	None	7 16 59	9?					Failed to orbit; destroyed by range safety officer
Explorer 6	1959 Δ 1	8 7 59	143	768	157	26 366	47 0	Decayed before 7 [illegible]; first earth photo radiation data to 10 6 59
Discoverer 5	1959 E 1	8 13 59	1 00	94 1	135	456	80 0	Decayed 9 28 59; capsule ejected into higher orbit
Beacon 2	None	8 14 59	10					Failed to orbit; first stage, upper stage malfunction
Discoverer 6	1959 Z 1	8 19 59	1 00	95 2	131	5 8	84 0	Decayed 10 20 59; capsule ejected orbit 17 recovery failed
Transit 1A	None	9 17 59	65					Failed to orbit; third stage ignition malfunction
Vanguard 3	1959 H 1	9 18 59	100	130 2	317	23 9	33 3	In orbit; radiation, micrometeoroid data until 12 11 59
Explorer 7	1959 I 1	10 13 59	9?	101.2	346	6 6	50 3	In orbit; magnetic field, solar flare data until 8 [illegible] 61
Discoverer 7	1959 K 1	11 7 59	1 00	94 6	99	519	81 6	Decayed 11 26 59; poor stabilization, capsule not ejected
Discoverer 8	1959 Λ 1	11 20 59	1700	103 7	120	103	80 6	Decayed 3 8 60; capsule overshot recovery area on orbit [illegible]
Atlas Able 4 (Pioneer)	None	11 26 59	3 2					Lunar probe failed; payload shroud broke away after 45 seconds
Discoverer 9	None	2 4 60	1300					Failed to orbit; premature first stage cutoff
Discoverer 10	None	2 19 60	1700					Failed to orbit; destroyed by range safety officer
Midas 1	None	2 26 60	4500					Failed to orbit; second stage failed to separate
Pioneer 5	1960 A 1	3 11 60	95	312 days	0.861 AU	995AU	3 35	In solar orbit; solar system data to 22.5 million miles until 6 26 60
Explorer S-46	None	3 23 60	[illegible]					Failed to orbit; apparent upper stage ignition malfunction
Tiros 1	1960 B 2	4 1 60	63	99 2	430	468	48 3	In orbit; first metsat, sent 22 952 photos until 6 17 60

Name	International designation	Launch date	Payload weight (pounds)	Period (minutes)	Perigee (statute miles)	Apogee (statute miles)	Inclination from equator (degrees)	Status
Transit 1B	1960 Γ 2	4 13 60	265	95 8	232	463	51 3	In orbit initial navigational data transmitted until 7 12 60
Discoverer 11	1960 Δ 1	4 15 60	1700	92 3	103	375	80 1	Decayed 4 26 60 capsule ejected on orbit 17 recovery failed
Echo A 10	None	5 13 60	132					Failed to orbit second stage attitude control malfunction
Midas 2	1960 Z 1	5 24 60	5000	94 4	299	321	33 0	In orbit data link quit second day
Transit 2A	1960 H 1	6 22 60	[illegible]	101 7	389	665	66 7	In orbit returned navigation geodetic data until 1 8 62
Solrad 1	1960 H 2		42	101 6	382	657	66 8	In orbit first satellite returned solar X ray data until 1 4 61
Discoverer 12	None	6 29 60	1700					Failed to orbit second stage attitude instability
Discoverer 13	1960 Θ 1	8 10 60	1700	94 1	157	431	82 8	Decayed 11 14 60 first recovery from ocean on orbit 17
Echo 1	1960 I 1	8 12 60	166	118 2	941	1052	47 2	In orbit first passive comsat relayed voice and TV signals
Discoverer 14	1960 K 1	8 18 60	1700	94 5	113	50	79 6	Decayed 9 16 60 first midair capsule recovery on orbit 17
Courier 1A	None	8 18 60	500					Failed to orbit booster exploded 2 5 minutes after launch
Discoverer 15	1960 M 1	9 13 60	1700	94 2	125	469	80 9	Decayed 10 18 60 capsule ejected 17th pass lost in ocean
Atlas Able 5A (Pioneer)	None	9 25 60	387					Lunar probe failed second stage oxidizer system malfunction
Courier 1B	1960 N 1	10 4 60	500	106 9	586	767	28 3	In orbit first active repeater comsat operated for 17 days
Samos 1	None	10-11 60	4100					Failed to orbit second stage ignited but didn't reach orbit reconnaissance satellite
Discoverer 16	None	10 26 60	2100					Failed to orbit second stage booster failed to separate
Explorer 8	1960 Ξ 1	11 3 60	90	112 7	285	1422	50 0	In orbit ionospheric research satellite tx until 1 [illegible] 60

Discoverer 17	1960 O 1	11 12 60	2100	96.4	[illegible]	[illegible]	[illegible]	[illegible] orbit 51
Tiros 2	1960 Π 1	11 23 60	[illegible]	98 3	[illegible]	452	48 5	In orbit ret med 50 156 cloud cover photos until 12 4 61
Transit 3A/ Solrad 2	None	11 30 60	205/40					Failed to orbit destroyed by range safety officer
Explorer S 56	None	12 4 60	14					Failed to orbit second stage ignition malfunction
Discoverer 18	1960 Σ 1	12 7 60	2100	93 8	145	4 6	80 0	Decayed 4 2 61 m da e capsule reco ery on o bit 48
Atlas Able [illegible] (Pioneer)	None	12 15 60	388					Lunar probe failed exploded 0 seconds after lift off
Discoverer 19	1960 T 1	[illegible] 0 60	2100	93 0	128	390	82 8	Decayed 1 23 61 infrared experiments no reentry capsule
Samos 2	1961 A 1	1 31 61	4100	95 0	300	350	97 0	In orbit ret ned micrometeorite impact data
Explorer 9	1961 Δ 1	2 16 61	15	118 3	395	1605	38 6	Decayed 4 9 64 12 foot balloon to study atmospheric density
Discoverer 20	1961 E 1	2 17 61	2450	95 4	177	486	80 4	Decayed 7 28 62 programmer failure no capsule ejection
Discoverer 21	1961 Z 1	2 18 61	2100	93 8	149	659	80 7	Decayed 4 20 62 infrared e periments no reentry capsule
Transit 3B/ Lofti 1	1961 H 1	2 21 61	250/57	94.5	[illegible]	511	28 4	Decayed 3 30 61 second stage satellites failed to separate na sat/very low frequency e perime t
Explorer S 45	None	2 24 61	74					Failed to orbit third and fourth stage ignition malfunction
Explorer 10	1961 K 1	3 25 61	[illegible]	[illegible] hrs	100	145 000	33 0	Position uncertain magnetic field data for planned 60 hours
Discoverer 22	None	3 30 61	2100					Failed to orbit second stage control system malfunctio
Discoverer 23	1961 Λ 1	4 8 61	2100	101 2	126	882	89 1	Decayed 4 16 [illegible] capsule into separate orbit no reco ery
Mercury Atlas 3	None	4 25 61	000					Failed to orbit destroyed by range safety off r
Explorer 11	1961 N 1	4 27 61	[illegible]	108 1	304	1113	28 8	In orbit gamma ray counter returned data until 1 1 6 61
Explorer S 45A	None	5 [illegible] 61	75					Failed to orbit second stage ignition malfunction

Discoverer 31	1961 AB 1	9-17-61	2100	91.0	152	255	82.7	Decayed 10-26-61 capsule separation failed
Discoverer 32	1961 AΓ 1	10-13-61	2100	90.8	[illegible]	246	81.7	Decayed 11 [illegible] 61 midair capsule recovery on orbit 18
Midas 4	1961 AΔ 1	10-21-61	3500	166.0	2058	324	95.9	In orbit West Ford ejected but dipole antenna failed to disperse
Discoverer [illegible]	None	10-23-61	2100					Failed to orbit launch vehicle shut down prematurely
Mercury Scout 1	None	11-1-61	[illegible]					Failed to orbit destroyed by range safety officer
Discoverer 34	1961 AE 1	11-5-61	2100	97.2	134	637	82.7	Decayed 12-7-6[illegible] malfunction prevented capsule ejection
Discoverer 35	1961 AZ 1	11-15-61	2100	89.8	147	173	81.6	Decayed 12-3-61 capsule recovered in midair on orbit 18
Transit 4B	1961 AH 1	11-15-61	190	105.6	582	700	3[illegible].4	In orbit transmitted until 1-7-62 SNAP 3 operated 8 months
Traac	1961 AH 2		240	105.6	562	720	32.4	In orbit gravity gradient experiment boom failed to extend
Ranger 2	1961 AΘ 1	11-18-61	675	88.5	98	147	33.3	Decayed 11-18-61 attempt to reach deep space orbit failed
None	None	11-22-61						Failed to orbit classified payload
Mercury Atlas 5	1961 AI 1	11-29-61	2900	88.5	100	148	32.5	Reentered 11 [illegible] 61 chimp Enos recovered after 2 orbits
Discoverer 36	1961 AK 1	12-12-61	2100	91.5	148	280	81.2	Decayed 3-8-6[illegible] capsule recovered from ocean after 64 orbits
Oscar 1	1961 AK 2		10	91.1	146	258	81.2	Decayed 1-31-6[illegible] first amateur radio comsat transmitted for [illegible] days
None	1961 AA 1	12-22-[illegible]		94.5	145	467	89.6	Decayed 8-14-6[illegible] classified payload
Discoverer 37	None	1-13-62	2100					Failed to orbit malfunction following second stage ignition
Composite 1	None	1-24-62	219					Failed to orbit low second stage thrust carried 5 satellites
Ranger 3	1962 A 1	1-26-62	727	406.4 days	.9839AU	1.163AU	398[illegible]	In solar orbit lunar probe missed moon by 2[illegible],862 miles
Tiros 4	1962 B 1	2-8-62	287	100.4	441	523	48.3	In orbit returned [illegible] 593 cloud cover photos until 1-6-[illegible]
Mercury Atlas 6	1962 Γ 1	2-20-62	2987	88.5	100	165	32.5	Reentered 2-20-6[illegible] first U.S. manned orbital mission J Glenn and Friendship 7 recovered after 3 orbits 4.9 hours

Name	International designation	Launch date	Payload weight (pounds)	Period (minutes)	Perigee (statute miles)	Apogee (statute miles)	Inclination from equator (degrees)	Status
None	1962 ς 1	2 21 62		90 7	108	233	82 0	Decayed 3 4 6 classified payload
Discoverer 38	1962 Σ 1	2 27 62	2100	90 7	208	300	82.2	Decayed 3 21 ▪ capsule recovered in midair after 65 orbits
OSO 1	1962 Z 1	3 7 62	458	96 2	344	370	32 8	In orbit transmitted data on 75 solar flares until 8 6-63
None	1962 H 1	3 7-62		95 9	147	428	90 9	Decayed 6-7 63 classified payload
None	1962 K 1	4 9 62		133 0	1731	2116	90.9	In orbit classified payload
None	1962 Λ 1	4 17 62		91 5	98	333	73.5	Decayed 5-28 6 classified payload
Ranger 4	1962 M 1	4 3 62	30					Impacted on moon timer failure experiments inoperative flight time 64 hours
Ariel I	1962 O 1	4 6 62	132	100 9	242	754	53 9	In orbit joint ionospheric satellite transmitted ionosphere X ray and cosmic ray data until 11 64
Injun 1B	None	4 6 62						Failed to orbit solar radiation satellite
None	1962 Π 1	4 6-62						Decayed 4 ?8 6 classified payload
None	1962 P 1	4 28 6		91 1	90	307	3.2	Decayed 5-28 6? classified payload
Anna 1A	None	5-10 6	355					Failed to orbit second stage ignition malfunction geodetic satellite
None	1962 Σ 1	5-15 6		94.0	180	401	82.5	Decayed 11 26-63 classified payload
None	None	5 23 62						Failed to orbit classified payload
Mercury Atlas 7	1962 T 1	5 4 62	2975	88.5	100	167	32 5	Reentered 5 24 62 Aurora 7" and S Carpenter recovered after 3 orbits 4 9 hours landed 250 ▪ les long
None	1962 Φ 1	5-?9 6		89 9	121	212	74 1	Decayed 6-11 6 classified payload
None	1962 X 1	6-1 62		90.5	131	241	43	Decayed 6- 8 ▪ classified payload
Oscar 2	1962 X 2		10	90 5	1?9	240	74 3	Decayed 6 21 ▪ amateur radio comsat, transmitted 18 days
None	1962 Ψ 1	6-17 6						Decayed 6-18 62 classified payload
None	1962 Ω 1	6 18 6		92.3	234	244	82 0	Decayed 10- 9 ▪ classified payload
Tiros 5	1962 AA 1	6-19 62	98	100.5	367	604	58 1	In orbit returned 58,2?6 cloud cover photos until 5 4 63
None	1962 AB 1	6 ?2-62		89 0	130	156	75 1	Decayed 7 7 62 classified payload
None	1962 AΓ 1	6 27 62		93 6	131	398	4 0	Decayed 9-14 62 classified payload

T lstar I	1962 AE I	7 10-62	170	157 8	593	3503	44 8	In o b t ctl e repeater comsat tran mitted u til 2 1 63
None	1962 AZ I	7 18 62		88 7	114	147	96 1	Decayed 7 7 62 l ssified paylo d
None	1962 AH I	7 20-62		90 0	1 2	218	70 3	Decayed 8 14 62 class fied payload
Mariner 1	None	7 22 62	446					Venus probe failed destroyed by ra ge safety offi r
None	1962 AΘ I	7 27 62		90 7	179	251	71 1	Decayed 8 [illegible] 62 cl s ified paylo d
None	1962 AK I	8 1 62		90.2	121	227	82 3	Decay d 8 26 62 cla ified payload
None	1962 AΛ I	8 5 62		88 6	127	127	96 3	Dec yed 8 6 62 classified payload
None	1962 AO I	8 23 62		99 6	388	526	98 6	In orb t class fied payload
Mariner 2	1962 AP I	8 26 62	447	348 days	7046AU	1 229AU	1 66	In solar orb t 21 594 mile Venus flyby data to 53 9 m il on miles
None	1962 AΣ I	8 8 62		90 4	114	250	65 2	Decayed 9 [illegible] 62 clas fied payload
None	1962 AT I	9-1 62		94 4	189	418	82 8	Decayed 10 26 64 class fied payload
None/ERS 2	1962 AX I	9 17 [illegible]	/1.5	92 8	1 4	383	81 9	Decayed 11 16 6 classified payload f led to eject ERS
Tiros 6	1962 AΨ I	9 18-62	81	98 7	425	444	58 2	In orbit ret r ed [illegible] 674 cloud cover photos until 10 11 [illegible]
None	1962 BB I	9 29-62		90 5	119	241	65 4	Decayed 10 14 62 class fied paylo d
Explorer 14	1962 BΓ I	10 2 62	89	2184	174	61 190	32 9	In o bit transmitted magneto phere data until 10 8 63
Mercury Atlas 8	1962 BΔ I	10 3 62	3029	89 0	100	176	32 5	Reentered 10 3 6 Sigma 7 with W Schirra recovered within 5 miles of carrier after 6 orbits 9 2 h urs
None	1962 BE I	10 9 62		90 9	103	"91	81 5	Decayed 11 16 62 cla ified payload
Ranger 5	1962 [illegible] I	10-18 62	755	366 days	9490AU	1 052AU	3901	In solar orb t lunar p obe m ssed moor by 450 miles
Starad	1962 BK I	10-26 62		147 8	120	3452	71 4	In orb t tra sm tted Starfish bomb artificial rad ation d ta until 1 [illegible] 63
E plorer 15	1962 BΛ I	10 27 [illegible]	[illegible]	312 0	[illegible]	10 760	18 0	In orb t transmitted Starfish data until 2 9 63
Anna [illegible]	1962 BM I	10-31 62	[illegible]	107 8	670	728	50 1	In orb t continues to provide some geodetic data
None	196 BO I	11 5 62		90 7	130	250	75 0	Decayed 12 3 62 class f d payload
None	1962 BΠ I	11 11 62		88 7	1 8	128	96 0	Decayed 11 12 6 classifed payload
None	1962 BP I	11 24 62		89 8	129	202	65 2	Decayed [illegible] classified payload
None	1962 BΣ I	12 4 62		89 2	119	175	65 0	Decayed [illegible] 8 62 classified payload
None	1962 BT I	12 12 62	114	116 0	[illegible]	1724	70 4	In orb t classified payload

Name	International designation	Launch date	Payload weight (pounds)	Period (minutes)	Perigee (statute miles)	Apogee (statute miles)	Inclination to equator (degrees)	Status
[illegible]	1962 BE 2			116.5	153	1 9	0.5	In orbit transmitted Starfish radiation decay data until 11 3 65
None	1962 BE 3			115.6	159	1700	0.5	Decayed 7 1 63 classified subsatellite
None	1962 BE 4			116.2	165	1728	70.4	In orbit classified subsatellite
None	1962 BE 5			116.0	146	1718	0.5	In orbit classified subsatellite
Relay 1	1962 BΥ 1	12 13 62	1 2	105.9	819	4612	47.5	In orbit comsat experiments conducted until 2 65
None	1962 BΦ 1	12 14 62		90.5	128	241	0.0	Decayed 1 6 63 classified payload
Explorer 16	1962 BX 1	12 16 62	[illegible]	104.4	466	733	5 0	In orbit transmitted micrometeoroid data until 7 2 63
None ERS 5 and 4	None	12 17 62						Failed to orbit classified payload ERS subsatellites
[illegible]	1962 BΨ 1	1 18 62	135	99.2	432	455	90.7	In orbit operational photo type power failure first day
None	1963 [illegible]	1 7 63		90.5	130	244	8 0	Decayed 1 4 63 classified payload
None	1963 3A	1 16 63		94.7	297	322	8 0	In orbit classified payload
Syncom 1	1963 4A	2 14 63	86	1426.8	21 195	22 955	33.5	In orbit communication lost at orbital injection synchronous comsat
None	1963 5A	2 19 63		97.8	304	496	100.5	In orbit classified payload
None	None	2 28 63						Failed to orbit classified payload first TAT use
None	None	3 18 63						Failed to orbit classified payload
None	1963 7A	4 1 63		90.6	1 9	54	73.4	Decayed 4 6 63 classified payload
Explorer 17	1963 9A	4 2 63	405	96.4	158	568	57.6	Decayed 11 24 66 atmospheric research data until 7 10 63
None	None	4 5 63						Failed to orbit classified payload
None	None	4 26 63						Failed to orbit classified payload
None	None	4 [illegible] 63						Failed to orbit classified payload
Telstar 2	1963 13A	5 7 63	175	225.0	604	6715	42.7	In orbit active repeater comsat transmitted until 5 65
None	1963 14A	5 9 63		166.6	2 49	2 90	87.4	In orbit ejected West Ford dipole antennae communication tests successful

ERS 5	1963 14B		1 5	168 5	2241	2297	87 4	In orbit returned solar cell damage data for [illegible] days
ERS 6	1963 14C		1.5	168 5	2250	228	87 3	In orbit duplicate of ERS 5 returned data for 89 days
Mercury Atlas 9	1963 15A	5-15 [illegible]	3033	88.5	100	166	32 5	Reentered 5 16 63 Faith 7 with L G Cooper recovered after [illegible] orbits [illegible] 3 hours completed Mercury program
None	1963 16A	5 18 63		91 1	95	301	74 5	Decayed 5 7 63 classified payload
None/ERS 7 and 8	None	6-12 63						Failed to orbit classified payload ERS subsatellites
None	1963 19A	6-12 63		90 7	127	263	81 9	Decayed 7 [illegible] classified payload
Lofti 2A	1963 21B	6-15 63		95.2	109	550	69 9	Decayed 7 18 63 very low frequency experiment
Solrad 6	1963 21C			95 1	109	546	69 9	Decayed 8 1 [illegible] solar radiation satellite
Radose	1963 21D			95.2	109	549	69 9	Decayed 7 30 [illegible] radiation dosimeter payload
None	1963 21E			95 0	109	541	69 9	Decayed 7 27 [illegible] classified payload
Surcal 1B	1963 21F			94 9	114	533	69 9	Decayed 7 5 63 surveillance calibration satellite
None	1963 22A	6-15 63		100 7	463	528	90 0	In orbit active gravity gradient stabilization system
Tiros 7	1963 24A	6 19 63	297	97 4	385	401	58 2	In orbit still active has provided over 1 5 000 photos
None	1963 25A	6-26-63	176	90 1	126	235	80 0	Decayed 7 26 63 classified payload
Hitch hiker 1	1963 [illegible]			132 6	201	2571	8 1	In orbit returned radiation data for more than 3 months
Geophysical Research Satellite	1963 [illegible]	6 28 63	[illegible]	102 1	267	808	49 8	In orbit space [illegible] experiment data ceased after 13 orbits
None	1963 27A	6-29 63		94 9	311	360	82 4	In orbit classified payload
None	1963 28A	7 12 63		88.2	111	124	95 4	Decayed 7 [illegible] 63 classified payload 100th Agena launched
None	1963 29A	7 18-63		89 8	120	206	82 9	Decayed 8 13 63 classified payload
None/ERS 10	1963 30A	7 18 63	/1.5	167 9	2274	2316	88 4	In orbit classified payload failed to eject ERS
ERS 9	1963 30B		1 5	167 9	2276	2319	88 4	In orbit returned radiation damage data for 113 days
None	1963 30D			168 0	2270	2326	88 4	In orbit classified payload

Name	International designation	Launch date	Payload weight (pounds)	Period (minutes)	Perigee (statute miles)	Apogee (statute miles)	Inclination from equator (degrees)	Status
Syncom 2	1963 31A	7-26-63	86	1454	22,062	22,750	33.1	In orbit synchronous communications over Indian Ocean used by Department of Defense
None	1963 27A	7-30-63		90.6	99	218	71.7	Decayed 8 13 63 classified payload
None	1963 30A	8-24-63		89.5	104	202	75.0	Decayed 9 12 63 classified payload
None	1963 35A	8-29-63		90.8	133	202	81.9	Decayed 11 7 63 classified payload
None	1963 35B			92.0	195	262	81.9	Decayed 9 [illegible] 63 classified payload
None	1963 36A	9-6-63		89.1	104	165	94.1	Decayed 9 [illegible] 63 classified payload
None	1963 37A	9-23-63		90.6	100	274	71.9	Decayed 10 12 [illegible] classified payload
None	None	9-27-63						Failed to orbit classified payload
None	1963 38B	9-28-63	160	107.4	6.6	714	89.9	In orbit classified payload with SNAP 9A power supply
None	1963 38C		120	107.4	687	05	89.9	In orbit active radiation satellite
Vela 1	1963 39A	10-16-63	297	108 hrs	63,442	70,831	38.3	In orbit nuclear detection satellite continues to transmit
ERS 12	1963 39B		4.5	39 hrs	129	64,531	36.7	In orbit subsatellite returned radiation data for 2 weeks
Vela 2	1963 39C		297	108.7 hrs	62,806	70,874	38.0	In orbit second active nuclear detection satellite
None	1963 41A	10-25-63		90.0	89	206	99.1	Decayed 10 29 63 classified payload
None	1963 41B			88.7	75	181	99.1	Decayed [illegible] 29 63 classified payload
None	1963 42A	10-29-63		90.9	[illegible]	218	89.9	Decayed 1 21 64 classified payload
None	1963 42B			95.4	195	349	89.9	Decayed 5 23 63 classified payload
None	None	11-9-63						Failed to orbit classified payload
Explorer 18	1963 46A	11-26-63	138	94.5 hrs	119	122,322	33.3	In orbit IMP A significant radiation data until 5 63
Atlas Centaur 2	1963 47A	11-27-63	10,000	107.7	303	1093	30.4	In orbit AC 2 second stage not considered a spacecraft
None	1963 48A	11-27-63		90.1	[illegible]	56	70.0	Decayed 12 15 63 classified payload
None	1963 49B	12-5-63		107.2	665	690	90.0	In orbit active classified payload SNAP 9A power supply
None	1963 49C			107.2	666	689	90.0	In orbit classified payload
None	1963 51A	12-18-63		88.8	76	165	97.9	Decayed 12 20 63 classified payload

Explorer 19	1963 53A	12 19 63	18	115 9	366	1467	8 6	In orbit 12 foot balloon identical to Explorer 9
Tiros 8	1963 54A	12 21 63	265	99.3	430	473	58 5	In orbit has returned over 100 000 cloud cover photos still active
None	1963 55A	12 21 63		89.3	107	189	64 9	Decayed 1 9 64 classified payload
None	1963 55B			91 7	196	45	64 5	Decayed 11 7 64 classified payload
None	1964 1A	1 11 64		103 5	563	5 8	69 9	In orbit classified payload
GGSE 1	1964 1B			103.5	560	585	70 0	In orbit [illegible] ity gradient stabilization experiment
Secor 1	1964 1C			103.5	563	578	69 9	In orbit geodetic satellite to pinpoint Pacific Islands
Solrad 7A	1964 [illegible]		100	103 5	563	5 8	69 9	In orbit solar radiation satellite tx until 7 66
None	1964 1E			103 5	555	591	69 9	In orbit classified payload
None	1964 2B	1 19 64		101 3	500	518	99 0	In orbit classified payload
None	1964 C			101 3	501	514	99 1	In orbit classified payload
Relay 2	1964 3A	1 21 64	172	194 7	1298	4606	46 0	In orbit comsat experiments conducted until 9 ?6 65
Echo 2	1964 4A	1 25 64	547	108 8	642	816	81 5	In orbit passive comsat first joint program with USSR
Saturn SA 5	1964 5A	1 ?9 64	37 700	94 8	164	471	31 5	Decayed 4 30 [illegible] second stage not considered a spacecraft
Ranger 6	1964 7A	1 30 64	804					Impacted on moon television system malfunctioned flight time 65 6 hours
None	1964 8A	2 15 64		90 9	119	[illegible]	75 1	Decayed 3 9 64 classified payload
None	1964 9A	2 5 64		88 2	[illegible]	[illegible]	9 7	Decayed 3 1 64 classified payload
None	1964 11A	2 27 64		94 6	302	319	82 1	In orbit classified payload
None	1964 12A	3 11 64		89 8	89	240	95 8	Decayed 3 16 64 classified payload
Beacon Explorer A	None	3 19 64	120					Failed to orbit insufficient third stage thrust
None	None	3 24 64						Failed to orbit classified payload
Ariel 2	1964 15A	3 27 64	150	101 3	180	843	51 6	In orbit joint ionospheric satellite returned data from British experiments until 11 64
Gemini 1 Titan 1	1964 18A	4 8 64	11 400	89 2	100	204	32 6	Decayed 4 12 64 boilerplate Gemini and second stage
None	None	4 21 64						Failed to orbit classified payload SNAP 9A power supply
None	1964 ?0A	4 23 64		89 4	95	209	103 6	Decayed 4 [illegible] 64 classified payload

Name	International designation	Launch date	Payload weight (pounds)	Period (minutes)	Perigee (statute miles)	Apogee (statute miles)	Inclination from equator (degrees)	Status
None	1964 22A	4 27 64		90 8	109	277	80 0	Decayed 5 6 64 classified payload
None	1964 24A	5 19 64		89 7	88	236	101 1	Decayed 5 ?? 64 classified payload
Saturn SA 6	1964 25A	5 28 64	37 300	88 5	124	140	31 8	Decayed 6-1 64 boilerplate Apollo modules and second stage
None	1964 26A	6 3 64		103 1	331	594	90 4	In orbit active classified payload tx on 150 400 mc
None	1964 27A	6 4 64		90 2	[illegible]	[illegible]	80 0	Decayed 6 10 64 classified payload
None	1964 30A	6 13 64		91 7	219	295	115 0	Decayed 7 2 64 payload included Star Flash experiment
None	1964 31A	6 17 64		101 6	514	5 3	99 8	In orbit classified payload
None	1964 31B			101 6	515	5 3	99 8	In orbit classified payload
None	1964 3 A	6-19 64		91 0	109	87	85 0	Decayed 9 16 64 classified payload
Environmental Science Research Satellite	None	6 25 64	176					Failed to orbit second stage exploded
Atlas Centaur 3	None	6 30 64						Failed to orbit Centaur flight test not considered a spacecraft
None	1964 35A	7 2 64		94 9	311	399	8 1	In orbit classified payload
None	1964 36A	7 6 64		89 4	75	215	9 9	Decayed 7 8 64 classified payload
None	1964 36B			90 9	1 9	216	93 0	Decayed 1 3 65 classified payload
None	1964 37A	7 10 64		91 0	[illegible]	86	85 0	Decayed 8 6-64 classified payload
Vela 3	1964 40A	7 17 64	319	100 3 hrs	63,369	65 024	39 5	In orbit active experiment in nuclear detection satellite
Vela 4	1964 40B		319	100 1 hrs	58 766	69 402	40 9	In orbit identical to Vela 3 continues to transmit
ERS 1	1964 40C		4 5	39.2 hrs	120	64 886	36 7	In orbit subsatellite returned radiation data until 1 25 65
Ranger 7	1964 41A	7 28 64	806					Impacted on moon first Ranger success returned 4308 photos flight time 68 6 hours
None	1964 43A	8 5 64		90 7	221	4076	80 0	Decayed 8 31 64 classified payload
None	1964 45A	8 14 64		89 0	93	191	95.5	Decayed 9 23 64 classified payload

None	1964 45B			127.4	165	2332	[illegible]	In orbit; P-11 radiation satellite
Syncom 3	1964 47A	8 19 64	86	1436.2	22,164	22,31[illegible]	0.1	In orbit; synchronous ... 180 W; now used ... Department of Defense control
None	1964 48A	8 21 64		91.6	217	[illegible]	115.0	[illegible] ...yed 3 31 65; payload included Star Flash experiment
Explorer 20	1964 51A	8 25 64	97	103.9	540	654	79.9	In orbit; returned ionospheric research data till 7 66
Nimbus 1	1964 52A	8 28 64	830	98.3	263	579	98.6	In orbit; nearly 27,000 cloud cover photos returned till 9 23 64
Titan stage	None	9 1 64						Failed to orbit; Titan 3A test; not considered a space effort
OGO 1	1964 54A	9 4 64	1073	64.0 hrs	175	92,82[illegible]	31.1	In orbit; spin stabilized; half of experiments returning data
None	1964 56A	9 14 64		90.8	119	[illegible]	8[illegible]	Decayed 10 6 64; classified payload
Saturn SA-7	1964 57A	9 18 64	36,700	88.4	114	141	31.7	Decayed 9 22 64; boilerplate Apollo modules and second stage
None	1964 58A	9 23 64		89.0	90	188	92.9	Decayed 9 28 64; classified payload
Explorer 21	1964 60A	10 3 64	136	35 hrs	1[illegible]2	59,2[illegible]3	33.5	In orbit; IMP C; apogee lower than planned; data sent till 10 15 65
None	1964 61A	10 5 64		90.4	109	43[illegible]	80.0	Decayed 10 [illegible]6 64; classified payload
None	1964 63B	10 6 64		106.6	657	673	89.9	In orbit; classified payload
None	1964 63C			106.6	6[illegible]	674	89.9	In orbit; classified payload
None	1964 63E			106.6	657	673	90.0	In orbit; classified payload
None	None	10 8 64						Failed to orbit; classified payload
Explorer 22	1964 64A	10 9 64	116	104.7	549	669	79.7	In orbit; transmitting ionospheric and geodetic data
None	1964 67A	10 17 [illegible]		90.6	117	258	75.0	Decayed 11 4 [illegible]; classified payload
None	1964 68A	10 23 64		88.6	86	168	95.6	Decayed 10 [illegible]8 64; classified payload
None	1964 68B			91.1	193	1[illegible]	95	Decayed 3 [illegible]5; classified payload
None	1964 68D			90.5	[illegible]	194	9[illegible]	Decayed 10 [illegible]9 64; classified payload
None	1964 71A	11 2 64		90.7	112	[illegible]	80.0	Decayed 11 28 [illegible]; classified payload
None	1964 72A	11 3 64		95.1	318	[illegible]27	82.0	In orbit; classified payload
Mariner 3	1964 73A	11 5 64	5[illegible]5	448.7 days	6150AU	8155AU	0.524	In solar orbit; shroud failure prevented Mars flyby
Explorer 23	1964 74A	11 6 64	[illegible]	99.2	288	[illegible]10	51.9	In orbit; 122 micrometeoroids recorded first year; transmitted until 7 [illegible]
None	1964 [illegible]A	11 18 64		89.7	112	1[illegible]	[illegible]0.0	Decayed 12 6 [illegible]; included ORBIS experiment

Name	International designation	Launch date	Payload weight (pounds)	Period (minutes)	Perigee (statute miles)	Apogee (statute miles)	Inclination to equator (degrees)	Status
Explorer 24	1964 76A	11 21 [illegible]	[illegible]	116 3	344	1551	81 4	In orbit; inflated balloon for atmospheric density studies
Explorer 25	1964 76B		[illegible]	116 3	345	1547	81 4	In orbit; radiation data; first NASA dual launch
Mariner 4	1964 77A	11 28 64	[illegible]	567.2 days	1 10894U	1 57304U	2.540	In solar orbit; returned 21 photos of Mars, still operating
None	1964 79A	12 4 64		89 7	94	[illegible]	97 0	Decayed 1 5 64; classified payload
Transtage	1964 81A	12 10 64	3750	88	112	121	32	Decayed 12 13 [illegible]; Titan 3 test, not considered a spacecraft
Atlas Centaur 4	1964 82A	12 11 64		87 9	101	107	30 6	Decayed 64; Centaur test, not considered a spacecraft
None	1964 83C	12 12 64	172	106 3	639	6 2	90 0	In orbit; returns magnetic field, electrical field data
None	1964 83D			106 3	639	6 2	90 0	In orbit; classified payload; 150-400 mc
None	1964 85A	12 19 64		90 3	114	257	3 0	Decayed 1 10 65; classified payload
Explorer 26	1964 86A	12 21 64	101	456	190	16,218	~0	In orbit; repeat of Explorer 15
None	1964 87A	12 21 64		89 4	144	155	~0 1	Decayed 1 11 65; classified payload
None	1965 2A	1 15 65		90 5	11	261	73 0	Decayed 2 9 65; classified payload
None [illegible]	1965 3A	1 18 65		97 7	[illegible]	511	98 8	In orbit; classified payload; first use of Thor Altair
OV1 1	None	1 21 6	188					Failed to orbit; launch from side pad of ABRES
Tiros 9	1965 4A	1 22 65	[illegible]	119.2	435	1602	96 4	In orbit; "cartwheel" Tiros, one camera operational
None	1965 [illegible]	1 23 65		88 9	91	181	102.3	Decayed 1 8 65; classified payload
OSO 2	1965 7A	2 3 65	545	96 5	343	393	32 9	In orbit; returned solar X-ray, gamma ray, ultraviolet ray data until 1 11 [illegible]
LES 1	1965 [illegible]	2 11 65	69	145 7	17 6	1744	32.2	In orbit; experimental comsat; ejected after 3 Transtage burns
Pegasus 1	1965 9A	2 16 65	23 000	97 0	308	462	31 7	In orbit; micrometeoroid detection; 2300 square feet of sensors

R g r 8	1965 10A	2 17 65	809					Impa ted on moo r t ed 7137 lose-up 1 r ph to flight time 64 9 hours
N ne	1965 13A	2 25 65		90 1	110	234	75 1	Decayed 9 18 65 clas fied payl ad
Atl s Centaur 5	None	3 2 65						F led to o b t Cent ur fl ght test not o idered a [illegible] ecr ft
None	1965 16A	3 9 65		103 5	564	584	70 1	In o b t cl ss fed p yload first 8 paylo d lau h
GGSE 2	1965 16B			103.5	562	583	70 1	In o b t gra ty gradient stab li at on e pe ment
GGSE 3	1965 16C			103.5	56	583	70 1	In orb t g i ty gradient st b l tion [illegible] me t
Solr d 7B	1965 16D			103 4	562	583	70 1	I orb t solar radi tion satellite
Sec r 3	1965 16E		40	103 4	562	583	70 1	In orb t a t e gend tic atellite
Oscar 3	1965 16F		[illegible]	103 5	564	585	70 1	In o t t mateur radio comsat transm tted f r 16 days
Sur 1	1965 16G			103 5	565	585	0 1	In orb t r e llance cal bration sat ll te f r Spa ir system
S rc l	1965 16H			103 5	563	586	70 1	In o b t dodecahedron surve llance cal brat on s tellite
None	1965 17A	3 11 65		97 8	184	634	89 9	Decayed 6 14 (cla fed p yload
Secor 2	1965 1 B		40	98 0	206	624	89 9	In orb t geodet c satell te failed to operate as pl nned
No e	196 19A	3 12 65		88 8	93	[illegible]	107 6	Dec yed 3 17 (cla fed payl d
None	1965 21A	3 17 65		97 7	3 6	475	99 1	In orb t lass fied p yload
Ranger 9	1965 23A	3 21 65	809					Imp cted on moon 5814 photos, landed in crater *Alphonsus* fl ght t me 64 5 hours
Gem ni 3	196 24A	3 3 65	7111	88.2	100	140	32 5	Reente ed 3 3 65 first ma ned orb tal mane vers V Grissom and J Young landed after 3 orb [illegible] 4 9 hours
None	196 6A	3 5 65		89 1	116	165	96 1	Decayed 4 4 65 clas fed paylo d
Snapshot	1965 27A	4 3 65	40	111.5	805	8 6	90 2	In orb t SNAP 10A power supply operated at mo e th [illegible] 00 watts for [illegible] days
Secor 4	1965 27B			111 6	797	816	90	In o b t geodet c satell te [illegible] led to operate as pl nned
No e	196 27E			111 5	795	817	90.2	In orb t cla fied payload
Ea ly B d	1965 28A	4 6 65	85	1436 4	21 748	22 733	0 1	In orb t com rc al commu cat on serv c in t ated (8 C5
None	1965 31A	4 28 65		88 7	95	171	95 7	Decayed 5 3 6 la fied paylo d

Name	International designation	Launch date	Payload weight (pounds)	Period (minutes)	Perigee (statute miles)	Apogee (statute miles)	Inclination to equator (degrees)	Status
None	1965 31B			95 0	302	349	95 3	In orbit; classified payload
Explorer 27	1965 32A	4 29 65	132	107 8	84	819	41 2	In orbit; geodetic and ionosphere research satellite
None	1965 33A	4 29 65		91 0	114	91	85 0	Decayed 5 6 65; classified payload
LES 2	1965 34B	5 6 65	[illegible]	315 2	1757	9384	31 4	In orbit; experimental comsat launched by Titan 3A
LCS 1	1965 34C		75	145 6	1727	1 37	32 1	In orbit; aluminum sphere for radar calibration studies
None	1965 37A	5 18 65		89 7	123	206	5 0	Decayed 6-16-65; classified payload
None	1965 38A	5 20 65		100 1	352	59?	98 7	In orbit; classified payload
Pegasus 2	1965 39A	5 25 65	23 100	97 3	314	466	31 7	In orbit; active meteoroid detection satellite
None	1965 41A	5 27 65		88 7	93	166	95 8	Decayed 6 1 65; classified payload
OV1 3	None	5 27 65	203					Failed to orbit; scientific satellite; launch vehicle exploded
Explorer 28	1965 42A	5 29 65	130	8558	121	163 851	33 9	In orbit; IMP C; returning magnetic fields, radiation data
Gemini 4	1965 43A	6 3 65	7879	89 0	100	175	32 0	Reentered 6-7 65. E. White performed 21 minute EVA experiment; landed with J. McDivitt after 66 orbits in 97 9 hours
None	1965 45A	6 9 65		89 9	100	?21	75 1	Decayed 6-?? 65; classified payload
Transtage	1965 47A	6 18 65	21 400	88 1	96	105	32 2	Decayed 6-?9 65; Titan 3C test; not considered a spacecraft
None	1965 48A	6 24 65	135	106 9	642	05	90 0	In orbit; navigational experiments operational navigation system
None	1965 50A	6 25 65		94 7	309	316	107 7	In orbit; classified payload
None	1965 50B			88 8	94	176	107 6	Decayed 6 ?9 65; classified payload
Tiros 10	1965 51A	7 2 65	80	100 6	458	517	98 6	In orbit; sun synchronous orbit; still operating
None	None	7 12 65						Failed to orbit; destroyed by range safety officer
None	1965 55A	7 16 65		94 4	291	3 0	70 2	In orbit; classified payload
None	1965 57A	7 19 65		90 9	114	277	85 1	Decayed 8 18 65; classified payload

Vela 5	1965 58A	7 20 65	334	6713	68 476	72,294	35 2	In orbit pe ment 1 1 x d tection s ll e
Vela 6	1965 58B		334	6716	63,217	75 561	35 0	I orbit 1 x V 1 5 by 180 both o tinue to tra m t
ERS 17	1965 58C		12	2595	129	69 723	[illegible]	In orbit mo itored radiation for 104 days
Pegasus 3	1965 60A	7 30 65	23 100	95 3	323	336	28 9	In orbit a ti e meteoroid detection satellite
None	1965 62A	8 3 65		89 1	93	191	107 5	Decayed 8 7 65 classified payload
None	1965 6 B			94 7	315	317	107 4	In orbit classified payload
Secor 5	1965 63A	8 10-65	45	122 1	702	1503	69	In orbit Scout flight test [illegible] ried geodetic s t ll t
Atlas Centaur 6	1965 64A	8 11 65	2100	31 days	105	509 829	8 6	In orbit Surveyor mod l lau hed to mulated moon
Surcal	1965 65B	8 13 65		108 1	680	738	90 0	In b t sur e ll nce cal bration satellite fa led to separate from second stage failed to deploy 200 foot antenna
Surcal	1965 65C			108 1	680	[illegible]	90 0	In orbit lodecahedron e tended [illegible] 5 foot antennae
S rc 1	1965 65E			108 1	680	738	90 0	In orbit tempsat 14 inch sphere painted dull black
None	1965 65F		135	108 1	680	[illegible]	90 0	In orbit satell e navsat at gments USN system
Surcal	1965 65H			108 1	680	738	90 0	In orbit 14 inch white sphere to check Spa t s te
S rcal	1965 65I			108 1	680	738	90 0	In orbit re tangular package with beacon tra i mitter
None	1965 67A	8 17 65		90 4	112	255	70 0	De ayed 10 11 65 cla fied payload
Gemini 5	1965 68A	8 1 65	7947	89 5	100	215	32 6	Rec tered 8 9 65 first extended U S manned flight L C Cooper and [illegible] Conrad l nded aft r 128 rbits 190 9 hours
REP	1965 68C		76	89 2	104	195	32 6	Decayed 8 27 65 p d ejected from Gemini 5
OAO [illegible]	None	8 5 65	6 0					F led to orbit premature third st [illegible] ign tion
None	None	9 2 65						F led to orbit le troyed by range afety off er
None	1965 72A	9 9 65		101 9	401	657	98 7	In orbit la fied paylo d
None	1965 74A	9 22 [illegible]		90 0	119	226	80 0	De ayed 10 11 65 cl ssified payload
None	1965 76A	9 30 65		88 [illegible]	98	164	95 6	Decay d 10 3 65 classified payload
OV1 2	1965 8A	10-5 65	190	1 5 7	256	2146	144 3	In orbit first su cessful OV1 ret rned radiation data

Name	International designation	Launch date	Payload weight (pounds)	Period (minutes)	Perigee (statute miles)	Apogee (statute miles)	Inclination to equator (degrees)	Status
None	1965 79A	10 5 65		89 8	126	201	75 1	Decayed 10 29 65 classified payload
OGO 2	1965 81A	10 14 65	1118	104 3	260	941	87 4	In orbit geophysical satellite most experiments returning data
OV2 1/LCS 2	1965 82A	10 15 65	375/75	99 7	439	492	32 6	In orbit Transtage broke up failed to [illegible] payloads
Gemini 6 Target	None	10 25 65	7200					Failed to orbit Agena exploded 6 minutes after [illegible]
None	1965 86A	10 28 65		90 6	107	268	75 0	Decayed 11 17 65 classified payload
Explorer 29	1965 89A	11 6 65	385	120 3	692	1414	59 4	In orbit GEOS geodetic satellite [illegible]
None	1965 90A	11 8 65		88 7	40	172	93 9	Decayed 11 11 65 classified payload
None	1965 90B							Decayed 11 9 65 classified payload
Explorer 30	1965 93A	11 18 65	125	102 8	440	548	59 7	In orbit solar radiation satellite final IQSY mission
Alouette	1965 98A	11 8 65	3 0	[illegible]	314	1856	79 8	In orbit [illegible] ionospheric [illegible] satellite
Explorer 31	1965 98B		218	121 5	314	1851	79 8	In orbit ionospheric data until 12 66 complemented Alouette
Gemini 7	1965 100A	12 4 65	8076	89 2	100	204	28 9	Recovered 12 18 65 F Borman and J Lovell [illegible] 0 orbits 330 6 hours served as Gemini 6 [illegible] target
None	1965 102A	12 9 65		90 5	112	6	80 0	Decayed 12 26 65 classified payload
Gemini 6	1965 104A	12 15 65	7817	88 5	100	162	28 9	Recovered 12 16 65 W Schirra and T Stafford rendezvoused within 1 foot of Gemini 7 landed after 17 orbits 5 9 hours
Pioneer 6	1965 105A	12 16 65	140	311 3 days	814AU	985AU	1695	In solar orbit returning [illegible] good solar and interplanetary data
OV2 3	1965 108A	12 21 65	[illegible]	589 7	110	20 903	26 4	In orbit radiation satellite Transtage [illegible] separation failed
LES 4	1965 108B		115	589 6	124	20 890	26 6	In orbit experimental all solid state comsat [illegible] X band
Oscar 4	1965 108C		29	587 5	101	0 847	26 8	In orbit amateur radio com [illegible]
LES 3	1965 108D		35	581 0	121	20 477	26 5	In orbit [illegible] signal generator for com [illegible]

None	1965 109A	12 21 65		105 0	564	675	89 1	In o bit [illegible] 400 mc
None	1965 110A	12 24 65		90 7	112	269	80 0	Decayed 1 20 66 cl sified payl ad
None	None	1 6 66						Fa led to o bit l3 fied p yload
None	1966 [illegible]	1 19 66		88 7	93	167	93 9	D cay d 1 25 66 clas fied p yload
None	1966 2B							Decayed 1 23 66 cl ssified payload
None	1966 5A	1 28 66		105 9	556	755	89 7	In orb t acti e classified payload tx on 150 400 mc
None	1966 7A	2 2 66		90 6	115	264	75 1	Decayed 2 2 66 classified payload
ESSA 1	1966 8A	2 3 66	305	100 2	432	521	97 9	In orb t first operatio al metsat one camera f led 7 25 66
None	1966 9A	2 9 66		94 8	316	318	82 1	In orb t classified p yload
None	1966 12A	15 66		89 0	92	182	96 5	Decayed 2 [illegible] 66 class fied payload
None	1966 12B							Decayed 2 18 66 class fied payload
None	1966 12C							Decayed [illegible] 2 66 class fied payload
ESSA 2	1966 16A	2 28 66	290	113 5	845	885	101 0	In orb t metsat comp letes initi l ESSA global system APT cameras
None	1966 18A	3 9 66		90 6	111	268	75 0	Decayed 3 29 66 class fied payload
Gem ni 8 Target	1966 19A	3 16 66	000	90 4	185	185	28 9	In orb t served as target eh cle for first d king n space
Geml i 8	1966 20A	3 16 66	8351	88 8	100	169	28 9	Reentered 3 16 66 initial docking test N Armstrong and D Scott landed after 6 5 orbits 10 7 hours due to short circuit
None	1966 22A	3 18 66		89 0	91	187	101 0	Decayed 3 24 66 clas ified payload
None	1966 B			88 2	85	147	100 9	Dec yed 3 23 66 lassified payload
None	1966 24A	3 25 66		105 3	[illegible]	701	89 7	In o b t active class fied payload tx nn 150 400 mc
OVI 4	1966 25A	3 30 66	193	103 9	550	630	144 5	In orb t returned zero [illegible] thermal control a periment data
OVI 5	1966 25B		252	104 4	613	639	144 7	In o bit optical radiation test gravity grad ent tabil zed
None	1966 26A	3 30 66		100 5	394	581	98 6	In orb t class f ed payload
None	1966 9A	4 7 66		89 6	120	194	75 1	Decayed 4 26 66 classif ed payload
Atla Centaur 8	1966 30A	4 7 66		89 6	109	198	30 8	Decayed 5 5 66 Centaur test not considered a spacecraft
OAO 1	1966 31A	4 8 66	3900	100 9	492	500	35 0	In orb t battery [illegible] led second day in orb t
None	1966 32A	4 19 [illegible]		89 6	86	253	116 9	Decayed 4 [illegible] class fied payload
OV3 1	1966 34A	4 22 66	152	151 7	20	3568	82 5	In orb t acti e rad at on resea ch satell te

Name	International designation	Launch date	Payload weight (pounds)	Period (minutes)	Perigee (statute miles)	Apogee (statute miles)	Inclination to equator (degrees)	Status
None	None	5 3 66						Failed to orbit; classified payload
None	1966 39A	5 14 66		89 4	81	2	110	Decayed 5 21 [illegible]; classified payload
None	1966 39B			95 4	392	345	109 9	In orbit; classified payload
Nimbus 2	1966 40A	5 15 66	91	108 1	684	754	100 3	In orbit; meteorological satellite returning TV and infrared cloud cover photos
Gemini 9 Target A	None	17 66	7170					Failed to orbit; Atlas control system malfunction
None	1966 41A	5 19 66		103 4	535	610	90 0	In orbit; active; classified payload; tx on 150 400 mc
None	1966 4[illegible] A	5 2[illegible] 66		89 0	111	168	60 0	Decayed 6 9 66; classified payload
Explorer 32	1966 44A	5 25 66	495	116 0	[illegible]	1629	64 7	In orbit; aeronomy experiments returned data to 1 12 66
Surveyor 1	1966 45A	5 30 66	596					Landed on moon; transmitted 11 150 photos up to 7 13 66; flight time 63 6 hours
Gemini 9 Target B	1966 46A	6 1 66	1700	90 4	185	185	28 9	Decayed 6 11 66; ATDA fairing separation failed
Gemini 9	1966 47A	6 3 66	8 68	88 8	100	169	28 9	Recovered 6 6 66; rendezvous and EVA tests carried out by T Stafford and E. Cernan; landed after 47 orbits 72 3 hours
None	1966 48A	6 5 66		88 4	[illegible]	127	86 9	Decayed 6 9 66; classified payload
None	1966 48B			88 3	75	75	87 0	Decayed 6 9 66; classified payload
OGO 3	1966 49A	6 6 66	1135	2907 9	170	75 768	30 9	In orbit; [illegible]0 experiments returning geophysical data
None	1966 51A	6 9 66		124 8	108	2246	90 1	Decayed 12 3 66; classified payload
Secor 6	1966 51B		38	125 1	104	266	90 1	In orbit; geodetic satellite
ERS 16	1966 51C		11	125 0	[illegible]	2251	90 0	In orbit; carried five metal-to-metal bonding experiments
OV3 4	1966 52A	6-10 66	175	145 2	399	2939	40 8	In orbit; active radiation research satellite
GGTS 1	1966 53A	6 16 66	104	1334 2	20 913	[illegible] 051	0 1	In orbit; gravity gradient test satellite; two booms deployed
IDCSP 1	1966 53B		100	1334 7	20 923	21 053	0 1	In orbit; one of 7 initial defense communication satellites

IDCSP 3	1966 53D		100	1336 6	20 936	[illegible] 088	0 1	I o bi i i i l d f nse com t
IDCSP 4	1966 53E		100	1340 8	20 935	21 194	0 0	I o bit ti l d f se mat
IDCSP 5	1966 53F		100	1344 0	20 949	21 258	0 1	I o b t i ti l d f se omsat
IDCSP 6	1966 53G		[illegible]	1338 6	20 936	[illegible] 139	0 2	I b t ti l def nse com t
IDCSP 7	1966 53H		100	1347 6	20 948	21 350	0 0	In rb t initial defe se com at
Non	1966 55A	6 21 66		90 2	121	2 8	80 1	Decayed 7 14 66 cl ss fied p yl d
Pageos	1966 56A	6 23 66	125	181 4	2607	662	87 1	In o b t *100 foot balloon photographed in* geodet c st dy
E plorer 33	1966 58A	7 1 66	206	8540 0	9880	[illegible] 560	28 7	In orb t IMP D ex esi e elocity p e c ted *J n r orb t act e*
Apollo SA 203	1966 59A	7 5 66	58 500	88 5	114	132	32 0	Decayed 7 5 [illegible] S IVB blown up not cons dered a spacecraft
No e	1966 62A	7 12 66		88 7	95	162	95 5	Decayed 7 20 [illegible] clas fied payload
OVI 7	No e	7 13 66	260					Fa led to o bit research satell te s injection motor fa led
OVI 8	1966 63A		25	105 2	612	635	144 2	In orb t [illegible] foot wire mesh sphere for passive comsat te ts
Gem ni 10 Target	1966 65A	7 18 66	7184	90 4	185	188	28 9	Decayed 12 29 66 ra s d Gem ni 10 s apogee to 476 m les
G mini 10	1966 66A	7 18 66	8295	88 8	100	168	28 9	Reentered 7 1 66 rend zvoused with Gemini 8 and 10 t rg ts J Young and M Coll ns landed after 46 orb ts 70 8 hours
No e	1966 69A	7 [illegible] 66		88 5	99	159	94 1	Decayed 8 6 66 classified payload first Titan 3B launch
OVS 3	1966 70A	8 4 66	165	136 6	220	2780	81 6	In orbit radi tion resea ch satell te active
No e	1966 72A	8 9 66		89 4	120	149	100 1	Decayed 9 11 66 cla s fied payload fi st Thorad launch
Lu ar Orbiter 1	1966 73A	8 10 66	853	217 2	117	1159	12 2	Imp t d on moon 10 29 66 photographed moon unt l 8 29 66
None	1966 74A	8 16 66		89 4	[illegible]	178	93 3	Decayed 8 24 [illegible] cla fied payload
None	1966 74B			94 9	318	324	93 2	In orb t class fied payload
Pioneer 7	1966 75A	8 17 66	140	402 9 d ys	1 010AU	1 125AU	097	In solar orbit ix solar a d interplanetary e per ments act e
None	1966 76A	8 17 66		106 8	654	687	88 9	In orb t active clas f ed paylo d tx on 150 400 mc
No e	1966 77A	8 19 66		167 6	[illegible] 85	2502	90 1	*In orb t classified payload*

	1966 99B		300	90 4	161	181	32 8	In orbit ... wh pe i ... test w th OV4 1T
OV1 6	1966 99C		445	90 4	180	180	32 9	Decayed 12 31 66 classified payload
OV4 1T	1966 99D		240	90 7	181	198	32 8	In orbit transmitter for whispering gallery experiment
Lunar Orbiter 2	1966 100A	11 6 66	861	216 8	129	1147	11 8	In lunar orbit returned 205 frames of lunar photography
None	1966 102A	11 8 66		89 4	107	188	100 1	Decayed 11 29 66 classified payload
Gemini 12 Target	1966 103A	11 11 66	7090	90 4	183	188	28 9	Decayed 1 23 66 positioned Gemini 12 for solar eclipse photos
Gemini 12	1966 104A	11 11 66	8294	89 0	100	175	28 9	Reentered 11 15 66 J Lovell and E. Aldrin concluded program with successful EVA tests landed after 59 orbits 94 6 hours
None	1966 109A	12 6 66		89 7	66	2 6	104 6	Decayed 12 14 66 classified payload
ATS 1	1966 110A	12 6 66	775	660	22,277	22 9 0	0 2	In orbit carrying out communication and meteorological tests
OV1 9	1966 111A	12 11 66	230	142 3	297	3004	99 4	In orbit radiation satellite to study biohazards active
OV1 10	1966 111B		287	98 9	403	479	93 5	In orbit gravity stabilized radiation satellite active
None	1966 113A	12 14 66		89 5	86	229	109 5	Decayed 1 4 66 classified payload
Biosatellite 1	1966 114A	12 14 66	940	90 7	191	197	33 5	In orbit failed to return biological capsule after 3 days
Pacific 1	1967 1A	1 11 67	192	1436 1	22,244	22 257	1 3	In orbit transpacific communication service initiated 1 11 67
None	1967 2A	1 14 67		90 0	112	227	80 1	Decayed [illegible] 67 classified payload
IDCSP 8	1967 3A	1 18 67	100	1330	20 835	21 036	0 1	In orbit initial defense communication satellite
IDCSP 9	1967 [illegible]	1 18 [illegible]	100	1331	20 854	21 031	0 0	In orbit initial defense communication satellite
IDCSP 10	1967 3C	1 18 67	100	1332	20 867	21 036	0 0	In orbit initial defense communication satellite
IDCSP 11	1967 [illegible]	1 18 67	100	1333	20 875	21 063	0 0	In orbit initial defense communication satellite
IDCSP 12	1967 [illegible]	1 18 6	100	1335	20 901	21 089	0 0	In orbit initial defense communication satellite

Name	International designation	Launch date	Payload weight (pounds)	Period (minutes)	Perigee (statute miles)	Apogee (statute miles)	Inclination to equator (degrees)	Status
IDCSP 13	1967 7F	1 18 67	100	1337	20 9[illegible]3	21 128	0 1	In orbit initial defense communication satellite
IDCSP 14	1967 7G	1 18 67	100	1340	[illegible]0 932	21 192	0 1	In orbit initial defense communication satellite
IDCSP 15	1967 7H	1 18 67	100	1343	20 935	21,2[illegible]5	0 0	In orbit initial defense communication satellite
ESSA 4	1967 6A	1 26 67	[illegible]90	113 [illegible]	8[illegible]2	894	10[illegible] 0	In orbit replaced ESSA 2 one of two APT cameras operational
OV3 5	None	1 31 67	270					Failed to orbit atmospheric research satellite
None	196[illegible] [illegible]A	2 2 67		88 8	96	183	102 4	Decayed 2 12 67 classified payload
Lunar Orbiter 3	1967 8A	2 4 67	850	218 8	[illegible]	1150	21	In lunar orbit returned 182 frames of lunar photography
None	1967 10A	2 8 67		101 5	409	544	98 0	In orbit classified payload
None	1967 1[illegible]A	2 [illegible] 67		90 1	111	255	80 0	Decayed 3 18 67 classified payload
None	1967 16A	2 24 67		89 8	85	219	107 0	Decayed 3 8 67 classified payload
OSO 3	1967 20A	3 8 67	[illegible]	95 9	336	354	3[illegible] 9	In orbit solar observatory nine experiments returning data
Atlantic 2	1967 26A	3 22 67	192	1436.1	22,240	22,[illegible]54	2 0	In orbit completes Intelsat II communication system
None	1967 29A	3 30 67		90 1	118	261	85 0	In orbit classified payload

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